

# Greater Cambridge Partnership Integrated Ticketing Study



**PJA**Associates

Working with



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## 1. Management Summary

PJ Associates, working with ALCO Consulting were commissioned by The Greater Cambridge Partnership (GCP) to research public transport ticketing and automated fare collection (AFC) in the Greater Cambridge area with a view to defining a roadmap for the development of AFC over the coming 10 years in a future-proofed manner. The desired target of expectation is a multi-token system offering multi-modal, multi-operator through ticketing supporting a variety of service access tokens (smartcards and mobile phones) and offering capped, best fares regardless of the ticketing token used and the ticketing product selected.

That this is achievable is not in doubt bearing in mind that other schemes operating in the UK have already demonstrated this capability. Instead, the issues for GCP which will influence its decision on the route to take in the achievement of its goal are:

- Systems based on the ITSO Specification for smartcard ticketing are in widespread use, including for concessions which have been deployed nationally. The DfT is continuing to strongly promote ITSO based schemes, which have been or are being adopted by rail and some bus operators. ITSO uses a distributed data approach known as Card-Based where tickets are stored in the smartcard;
- Supporting the ITSO Specification would seem to be essential; however, it is coming up to 18 years since it first appeared, it has not been updated with a new release for 10 years and it is expensive to install and operate. Consequently, ITSO is not seen as a long-term solution by many operators but in the context of GCP could be seen as a steppingstone towards its goal;
- Some services run through Cambridge and are operated by national organisations which have their own AFC schemes and, depending on the solution decided upon by the GCP, they may or may not be willing to join in with GCP's multi-operator plans;
- The latest technology and scheme designs acknowledge that good communications are now available between a base and all public transport vehicles, including those that move (i.e. buses). As a result, passenger trip data can be held in a central database (i.e. in the 'cloud') rather than in the passenger's smartcard. This way of working is more flexible and cheaper to operate. It is known as Account Based Ticketing (ABT), a UK example being London's "Contactless" ticketing scheme.
- In an ABT scheme, customers use a "Token" to identify themselves to the system, which can be either a contactless bank card, a transport smartcard or a mobile phone app. Information about who presented their token, when and where they presented it and whether they were entering or exiting the transport network, is sent to the central database which assembles the movement data of the person and is able to calculate the fare to be charged.

The choices for GCP are clear, either:

- Base the long-term strategy on ITSO card-based systems which have many disadvantages but are well tried and tested; or

- Base the long-term strategy on an account-based approach which whilst there are installations in live operation, is still a developing technology.

This study concludes that the account-based approach should be selected as the long-term goal and the roadmap should be based on this. The reasons are set down in detail in chapters 3 to 8 of this report. They may be summarised thus:

- By the time GCP installs its system account based (ABT) systems are likely to be well proven and mature, with “off-the-shelf” systems likely to be available;
- Capital cost for ABT systems may be higher, however ABT operational costs can be significantly lower than the card-based approach;
- ABT has increased flexibility and lower on-going management cost and therefore it is easier to support the long-term functionality objectives of GCP;
- The centralised database of ABT lends itself to extension including customer relationship management, data sharing, collection and analytics;
- ABT is good base for other initiatives such as MaaS (“Mobility as a Service”) operation, smart city development and addressing climate change;
- Consequently, many operators are looking to move away from ‘traditional’ card-based schemes towards account-based schemes;
- The timeframe to realisation of objectives for the approach recommended is no longer than when taking a card-based approach.

This study shows that a stepping stone approach could be taken to implementation, supporting incrementally, contactless bank cards (cEMV), and leading to account based multi-modal ticketing with best fare calculation (capping). Operator’s existing card based ITSO schemes, for example, those offered by the major operators, may continue in parallel until fully transitioned across to the ABT system.

If it is decided that the timescale to the first appearance of something tangible in the implementation of the ABT scheme is too long, then a simpler “Quick Win” could be implemented as an incremental stepping stone. If this approach is favoured by GCP, notwithstanding it could delay the development of the main scheme somewhat, our recommendation for a quick win would be for cEMV cards to be accepted on all Greater Cambridge services as a payment method for flat fare and single journey tickets. In this case, the fare is known and will be deducted on boarding via the normal banking route. This simple use of a contactless bank card is known as cEMV model 1 use.

An alternative Quick Win might be joining in with someone else’s system operating in or through the region, for example, Stagecoach. However, we have no knowledge that this is practical or could be available to GCP. The same thoughts might also be applied to the existing Multibus ticket but again, we have no basis to think this would be achievable within a shorter timescale compared to the full scheme. Clearly, further investigation is required if GCP wish to consider either of these approaches.

The costs involved in implementing an AFC scheme are estimated in this study and presented as rough order of magnitude (ROM) costs. Nevertheless, the history of other installations shows a very wide range of costs, from below £1m to several hundred million. This variation depends on whether a single source supplier; an integration company; self-management by the client; a “new breed” supplier using off the shelf hardware and software; or a traditional supplier is chosen. As and when GCP decide upon the solution they prefer and their approach to implementation, a more accurate costing may be produced.

Section 6 of the report discusses future proofing and developing systems that can provide the base for cost effective MaaS, big data collection and analytics, smart cities and helping GCP play its part in combatting climate change. By taking a technical, commercial or political perspective, different issues will become paramount. It is hoped that this report provides all parties with sufficient information to allow them to determine the best way forward based on their specific judgement criteria.

Timescales and rough order of magnitude costs have been estimated for the recommended ABT solution. It is estimated that the complete system could be delivered by mid-2022, dependent upon a prompt start and funding availability. The up-front costs at 2018 prices are estimated to be around £1.5M, and the annual operating costs, again at 2018 prices, are estimated to be around £400k. In reaching these conclusions a number of assumptions have been made, which are set out in the main body of the report.

## 1.1 Key Recommendations

1.	We confirm that multimodal, multi-operator through ticketing with capping and using cEMV bankcards, mobile phone apps and transport smartcards within the Greater Cambridge area is achievable on a realistic timescale.
2.	The target goal should be for an Account Based Ticketing System fully supporting this functionality.
3.	Operation of existing ITSO based schemes alongside the ABT system may be continued until transition is complete.
4.	If politically advisable, a parallel “quick win” could be provided. Our recommendation for this would be to support cEMV bank cards used as payment and access tokens for known fares (flat fares and single journey tickets).

*Table 1 – Key Recommendations*

## 2. Introduction

This section is intended to highlight the purpose of this study and position it in the context of the current situation among the players and stakeholders involved in the provision of transport services and fare collection.

Nothing new is introduced here, the intention being to set down what is already known in this Introduction section, with subsequent sections concentrating on the provision of new information and its implications.

### 2.1 Organisations and groups

#### 2.1.1 Organisations and groups

Figure 1 highlights the various organisations and groups with an interest in transport services covering Cambridgeshire and its environs. In practice there will be differing interests applying to each group with some overlap between groups. This makes it complicated to define both the governance and operational structure of a multi-operator, multi-modal, integrated ticketing environment. However, for the purposes of this report, we have not considered these complications to any great level of detail and use the diagram only to note the geographic spread of bus services included in our study.

In addition, we have been asked to include heavy rail in our sphere of interest. The services covering Cambridgeshire operate far wider than the region considered above, and we will only consider the routes in and out of Cambridge.

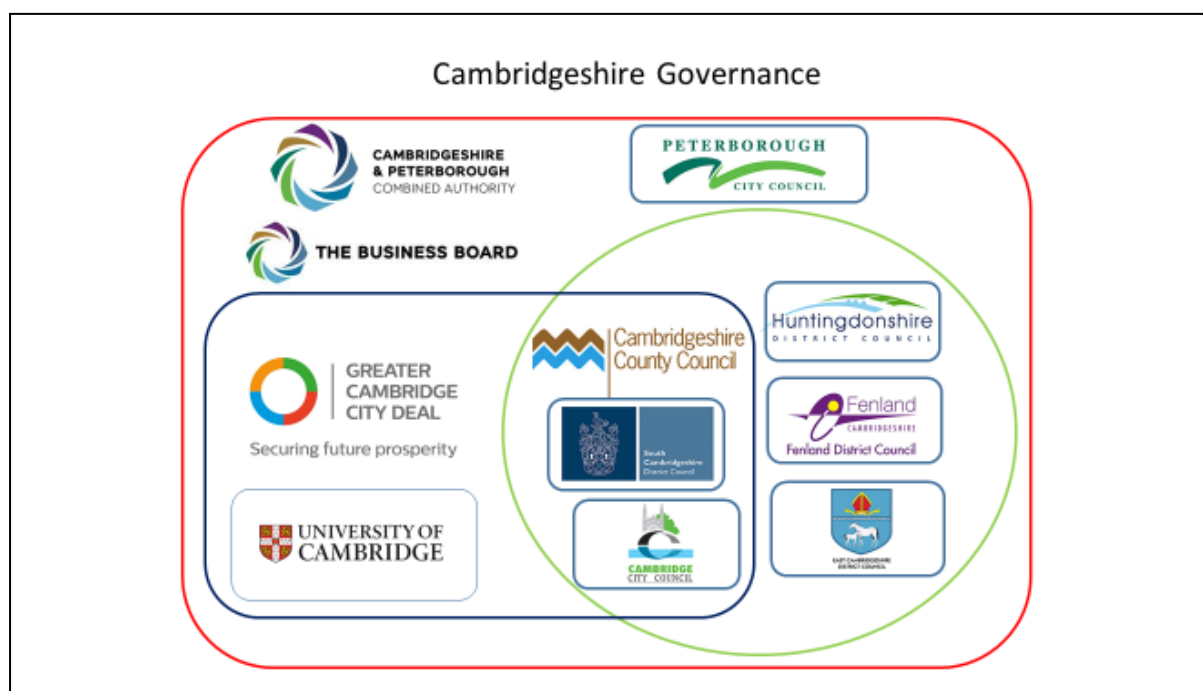


Figure 1 – Cambridgeshire Governance



### 2.1.2 Operators

It is noted that the heavy rail operators serving the region and the national bus operator(s) under consideration, all have their own schemes for automated ticketing, rendering it difficult for them to fit in with any local integrated ticketing scheme. In addition, even if ticketing interoperability was achieved, data sharing would be difficult for competing operators to accept, although it would be necessary for multi-operator journey capping. However, the DfT plans to compel operators to open up bus databases which should overcome the difficulties in this area<sup>1</sup>. These issues are addressed in subsequent sections of this report.

Table 2 shows the operators considered in this study:

Operator	Mode	Note
Stagecoach	Bus	Own national ticketing scheme
Whippet	Bus	Going through a period of uncertainty and change
Small operators (section 3.3.4)	Bus	Limited incentive or funding
National Express	Coach	Own national ticketing scheme
Stagecoach	Coach	Own national ticketing scheme
Community Transport	Bus	Uncertain what exists and whether in scope
Abellio Greater Anglia	Heavy Rail	Following RDG specifications
Govia Thameslink	Heavy Rail	Following RDG specifications
Cross Country	Heavy Rail	Following RDG specifications

Table 2 – In Scope Operators

### 2.1.3 Stakeholders

Section 2.1.1 highlights the involved groups, their inter-relationships and overlaps. We note that we are not required to consider these groups as a whole; however, we do need to consider them individually as stakeholders.

Stakeholder	Note
The Greater Cambridge Partnership	Owner of this study
Cambridge & Peterborough Combined Authority	Led by elected Mayor James Palmer. Comprises Cambridge City Council, The Greater Cambridge Partnership, East Cambridgeshire District Council, Fenland District Council, Huntingdonshire District Council, Peterborough City Council, South Cambridgeshire District Council and The Business Board.
Cambridge City Council	
East Cambridgeshire District Council	
Fenland District Council	
Huntingdonshire District Council	
Peterborough City Council	
South Cambridgeshire District Council	
Greater Cambridge Partnership	Administers the City Deal. Comprises Cambridge City Council, The Greater Cambridge Partnership, South Cambridgeshire District Council and Cambridge University.
The Business Board	The Local Enterprise Partnership (LEP). Members include the Mayor and Deputy Mayor, and various business leaders.
Transit service providers	See 2.1.2
University of Cambridge	

Table 3 - Stakeholders

<sup>1</sup> Bus Services Act 2017: bus open data consultation response as reported in Local Transport Today 29<sup>th</sup> March 2019.

## 2.2 Activities, plans and aspirations

Today, travellers using public transport in Cambridgeshire must use either cash or a variety of tokens (see section 2.3.3), including paper, magnetic stripe, chip based plastic cards including ITSO and bank cEMV cards, and mobile phones. In addition, the available products vary across operator and mode of transport, and the price charged for the same journey by different operators varies, in some cases significantly.

This situation is not conducive to persuading people to travel by public transport. What they want is consistency, ease of use and faster boarding. This study is a step along the path for Cambridgeshire and its associated nearby regions to develop a system used by all operators and meeting all the requirements of passengers on public service vehicles. It is clear that to meet these requirements both technical and commercial issues must be addressed. This study concentrates on the technical issues but alludes where necessary to commercial, political and business issues.

## 2.3 Integration

Integration of services, providing travellers with a unified method to gather all the travel planning information they require, make their bookings, pay for travel and access the travel services to make their journeys, is clearly a requirement, and one which we address in this study. In order to determine what the options are for moving forward it is first necessary to categorise the possible requirements in more detail.

### 2.3.1 Supporting services

The prospective traveller may wish to be provided with information allowing them to plan their travel and prepare for it in advance of setting off on their journey. Supporting services might provide bus and train routes, timetables and charges. Having selected their journey, he or she could then wish to pay and receive a receipt.

If the traveller is to receive a joined-up, easy to use service, supporting services should be integrated with transport service access tokens plus possibly an e-purse for use on the journey to make small purchases.

All of this is available now in complete or partial form from a variety of operators but what is really needed is for all this to be fully available across all operators and all modes of transport in the region, preferably including both public and private services.

### 2.3.2 Modes and operators

In addition to the above, in order to make the supporting services fully available to meet the needs of the traveller, it is necessary for the supporting services to operate in a multimodal, multi-operator environment including all travel related services such as cycle hire, parking and tolling, subject to Council policy. In particular, the first and last mile problem must be resolved.

### 2.3.3 Tokens

In order to achieve the level of integration required to provide the services described above it is necessary for electronic tokens to be interoperable across operators. Tokens can be, for example, a smartcard, a bank card or a mobile phone app. Tokens without secure electronic functionality are unlikely to satisfy the requirements for a fraud resistant integrated travel scheme.

However, this situation is clouded by the desires of the traveller. Past studies and market surveys have shown that while many people are happy to use their mobile phone, many more do not wish to use them or do not have a smart phone. We have found groups who wish to use their bank card and groups who wish to use the bespoke travel card, and other groups wishing to communicate with the transport service in other ways. It is our experience that to properly satisfy all sections of the travelling public, a variety of token types must be available.

#### 2.3.4 Fares and products

In a multimodal, multi-operator environment, the question of fares and products must be addressed. From a competitive standpoint it may be realistic and desirable for operators to compete with each other over similar routes, although the local authority may not approve if excessive services are provided on profitable routes at the expense of less profitable routes. The rules for the implementation of multi-operator tickets are set by the Competition and Markets Authority Public Transport Block Exemption<sup>2</sup>.

However, one of the main concerns among travellers is to achieve best fare. Historically we have seen this issue come into play on heavy rail multi-leg journeys where significantly different prices can be charged for the same journey dependent on how the journey was booked. In the case of bus journeys, best fare may be achieved by manual selection of ticket type, such as a season ticket and route choice, coupled with the operator's implementation of daily and weekly capping and special offer discounts.

If we consider a multi-leg multi-operator journey, a way must be found to reflect capping as a discount across all operator's transport used on the journey. Therefore, not only do we have to have agreement on fares, it is also necessary to have agreement on the apportionment of discounts and price caps. In many instances this proves to be a more difficult problem than any technical ones. This issue is addressed in more detail in section 4.2.3.

## 2.4 This study

### 2.4.1 Aims and objectives

The Greater Cambridge Partnership wishes to improve the public transport travel experience for travellers including commuters, shoppers, tourists and those with special needs. This can be achieved by providing a single ticketing scheme for all public transport services in the Greater Cambridge area. The aim of this study is to show the GCP what can be done to achieve this, how it can be done, when it can be done and at what cost.

Clearly there are alternative scenarios operating at a faster or slower pace, taking up different technologies at different times and taking different routes to the ultimate goal; noting of course that over the period of development, technologies, services and requirements will change.

This study sets out to identify routes and stages in the move to satisfying traveller requirements so that public transport take-up will increase, and Cambridgeshire will become a better place to live, work and play as well as meeting its green agenda requirements.

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<sup>2</sup>

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/553470/cma53-public-transport-ticketing-schemes-block-exemption-guidance.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/553470/cma53-public-transport-ticketing-schemes-block-exemption-guidance.pdf)

To be specific concerning objectives, what is the Greater Cambridge Partnership trying to achieve for itself, its stakeholders and its travelling customers?

**For the Council:**

- Increasing use of public transport and reducing use of private cars thereby reducing congestion and pollution;
- More equitable transport system
- Lower costs;
- More flexible operation;
- Reduced risk;
- High public satisfaction;
- World Class Public Transport system

**For Stakeholders:**

- Lower costs;
- More flexible operation;
- Reduced risk;
- High public satisfaction;
- In charge of their own destiny;
- Taking cash out of the system;
- Data for analysis while remaining competitive.

**For travellers:**

- Making it as easy as possible to use public transport;
- On time transport;
- Comfortable and fast journey;
- Integrated modal interchanges;
- Lower costs;
- Automatic Best Fare provision;
- Flexible ticketing covering multi-modal, multi-operator journeys;
- Token of choice;
- Good advance and real time information provision.

## 2.4.2 Scope

The scope of this study is to identify what needs to be done to move the current ticketing situation in Cambridgeshire to one which is conducive to expanding public transport in the region by making the ticketing and boarding experience faster, easier to use and more enjoyable. This study also considers how this desirable situation may be achieved, listing alternative approaches and making recommendations.

In this respect consideration will be given to indicative costs, potential benefits, likely timescales and requirements of non-technical issues such as required policy changes, fare structure changes and alterations to bus configurations. Although the study relies upon the expertise and experience of

those carrying out the study, all findings and recommendations will be backed up by a traceable rationale.

### 2.4.3 Layout of the report

This report is divided into discrete sections which may be read individually or together.

- Section 1: a management summary of the report and its recommendations;
- Section 2: an introduction to the report setting down the information required by the study that is already known and available;
- Section 3: a review of what they are and how the various ticketing systems used by different operators in the regions under consideration, work, overlap and possibly confuse the travelling public as a base for proposing what needs to be done to remedy the situation and create the environment desired by The Greater Cambridge Partnership;
- Section 4: a look at the various technical options that may play a part in providing an integrated solution. Consideration is given to technology maturity, functionality, the level of change required to implement it and the corresponding cost;
- Section 5: this section draws together the requirements and the technologies required to achieve them to produce an options assessment of the various ways that The Greater Cambridge Partnership's targets may be achieved. The assessment will include consideration of the non-technical issues as well as the technical issues
- Section 6: a review of the longer-term likely situation in transport fare collection and travel authorisation. This section offers a view of the direction to be taken by short to medium-term actions if the whole approach to the problem is to be future proofed;
- Section 7: based on all the foregoing sections, a set of recommendations as to the way forward following a developed plan and if possible, also achieving quick wins along the way. More than one approach is possible, and the key ones are graded;
- Section 8: in this section we set down a delivery plan for the approach we recommend, and then specify the next steps to be taken to take this forward. However, it is for The Greater Cambridge Partnership to make its own judgement as to which route to take and how to approach it, guided by our input.

### 3. Current ticketing context for Greater Cambridge

Section 2 identified the existing groups, players and services in place today. However, before being able to move forward, looking at new products and services and how and when they may be beneficially introduced, it is necessary to consider the context in which they are to operate.

#### 3.1 Existing multi-operator ticketing products

There are already a number of ticketing products in use in the region that can be used across operators in the region and, in some cases, outside the region/nationally.

##### 3.1.1 Multi-bus<sup>3</sup>

Multi-bus is a multi-operator bus ticket. Revenue “lies where it falls” therefore reconciliation and settlement are not required.

The ticket is paper based, sold on bus and accepted by A2B Coaches, A&P Coaches, Myalls Coaches, Stagecoach Cambridgeshire, Stagecoach in Huntingdon, Stagecoach in the Fens, and Whippet Coaches. It is not accepted on Stagecoach Busway services A and B, and X5; Whippet Busway service D<sup>4</sup>; and Stagecoach service 11 between Newmarket and Bury St Edmunds. There are additional small operators who, according to the Council’s website, do not support the ticket.

Day and week passes are provided and can be purchased on-bus. Fares have been set by negotiation with the operators and increased annually by inflation. Take up is reported to be low. The ticket is not currently promoted.

##### 3.1.2 PlusBus<sup>5</sup>

PlusBus is a day pass issued by rail ticket retailers alongside a relevant rail ticket. It is paper based. Travellers to Cambridge are, along with Reading, the highest users of PlusBus tickets in the UK. Tickets can be used from Cambridge and Cambridge North stations, on services provided by Stagecoach and Whippet, and on the busway as far as the PlusBus zone limit. PlusBus tickets are currently issued only on paper, and not supported in mobile phone apps or ITSO cards.

##### 3.1.3 Busway card/ticket<sup>6</sup>

A smartcard and associated smart ticket had been proposed for use on busway services but has been abandoned because only one operator is currently using the busway.

##### 3.1.4 The English National Concessionary Travel Scheme (ENCTS)<sup>7</sup>

All bus operators in England are obliged to accept this pass, which is based on ITSO smartcard technology. The HOPS and card issuing facilities are provided by The Greater Cambridge Partnership.

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<sup>3</sup> Source: Cambridge County Council web site, and responses by Council officers.

<sup>4</sup> Whippet have recently withdrawn this service.

<sup>5</sup> Source: Internet

<sup>6</sup> Source: County Council

<sup>7</sup> Source: County Council

### 3.2 Payment Methods by Public Transport Service

We can summarise the above multi-operator ticket description with a mapping showing the complete picture.

Service	Mode	Payment Method								Notes
		Cash	ENCTS	PlusBus	Megarider	Multi-Bus	Busway Card	Mobile App	cEMV Card	
Busway	Guided Bus	Y	Y		Y		See note			Council owned, Stagecoach operated
Stagecoach	Bus	Y	Y	Y	Y	Y		Y	Y	
Whippet	Bus	Y	Y	Y		Y		Y		
Small operators	Bus	Y	Y			Y				
Coach Services	Coach	Y								Coach tickets are only purchased in advance, either at an agency or on-line.
Community Transport	Bus	Y								
Abellio Greater Anglia	Heavy Rail	Y						Y	Y	Mobile for ticket purchase
Govia Thameslink	Heavy Rail	Y						Y	Y	Mobile for ticket purchase
Cross Country	Heavy Rail	Y						Y	Y	Mobile for ticket purchase

Table 4 – Payment Methods by Public Transport Service

Note that Coach and Rail operators also accept “chip and pin” bank cards.

### 3.3 Current Bus Provision

#### 3.3.1 The Busway<sup>8</sup>

The Cambridge Busway runs from Cambridge to Huntingdon and St. Ives, and in the other direction to the Addenbrooke's Hospital. Services run on to Peterborough and Eddington, and a linked service runs from Addenbrooke's Hospital to Royston.

The Busway is owned and run by The Greater Cambridge Partnership. It is open to bus operators meeting technical and operational requirements, but is only currently used by Stagecoach services, Whippet having recently withdrawn.

#### 3.3.2 Stagecoach<sup>9</sup>

Stagecoach are the predominant bus operator in the Greater Cambridge area, operating local, longer distance<sup>10</sup> and Busway services. Stagecoach allow fares to be paid in a variety of ways:

- Cash on bus (paper ticket);
- Contactless bank card, Apple and Android pay on bus using model 1 (cash replacement, a paper ticket is issued);
- ENCTS;
- Multi-bus passes;
- Stagecoach's own ITSO smart Megarider period passes (purchased on-line); and
- Stagecoach's own mobile phone app.

Stagecoach use VIX<sup>11</sup> ETMs<sup>12</sup>.

#### 3.3.3 Whippet<sup>13</sup>

Whippet run local services in and around Cambridge but have recently withdrawn their Busway service. They support multiple fare options including:

- Cash on bus (paper ticket);
- ENCTS;
- Multi-bus passes;
- Their own period passes (paper based); and
- Their own mobile phone app.

They do not currently support ITSO commercial smart tickets or Contactless bank card payment but are understood to be exploring both options.

Whippet currently use VIX ETMs but are understood to be considering a change of supplier<sup>14</sup>.

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<sup>8</sup> Source: Cambridge County Council web site.

<sup>9</sup> Source: Stagecoach website.

<sup>10</sup> For example, the service to Bedford, Milton Keynes and Oxford.

<sup>11</sup> Source: Lucy Whitehead, Group Innovation Lead, Stagecoach.

<sup>12</sup> Electronic Ticket Machine for on-bus use.

<sup>13</sup> Sources: Whippet website, County Council.

<sup>14</sup> Source: Charlie Hamilton, Whippet.



### 3.3.4 Small Operators

The small operators support ENCTS, in some cases in the form of flash passes. Some have reported that their ETMs are “smartcard capable”, but it is not clear whether these are ITSO certified, or not<sup>15</sup>. Because they don’t accept ITSO electronically, it is assumed that they do not accept cEMV bank cards.

There are a number of small operators in the Greater Cambridge area, including A2B Coaches, A&P Coaches, the Big Green Bus Company, Dews, FACT, HACT, Lords, Myalls Coaches, and W&M Travel.

### 3.3.5 Community Transport Services<sup>16</sup>

There are 2 Dial-a-Ride schemes operating in the Greater Cambridge area: The Cambridge Dial-a-Ride scheme<sup>17</sup>; and a second scheme centred on Haverhill in Suffolk.

There are 32 volunteer car schemes serving the area, although some are centred outside the Greater Cambridge area.

### 3.3.6 Coach Services<sup>18</sup>

National Express operate coach services between Cambridge and various destinations, including Birmingham; Norwich; Peterborough; Stansted and Luton Airports; and London. Tickets can be purchased on-line, at some bus stations and via agents including three in Cambridge and also at the Peterborough visitor information centre. National Express also provide a journey planning and ticket purchase mobile phone app.

Stagecoach’s Megabus service provides services to longer distance destinations. Tickets must be purchased on-line.

These services are unlikely to be used for journeys within the Greater Cambridge area, and therefore are not considered further in this study.

### 3.3.7 Customer Perspective

It will be seen from Table 4 above that for full flexibility in choice of operator, including multi-leg, multi-operator journeys, cash remains king, which is not ideal for integrated ticketing. It will also be seen that the use of mobile phones and cEMV financial service cards are fast becoming the token of choice. Increasingly, customers are embracing modern technology, and don’t want to have multiple tokens simply to use public transport. They have become accustomed to convenience when paying, and for getting the best price for everything.

From this one may deduce that the days of the special, single operator travel token or card are numbered. However different user types want different token types and there is a significant group who will not or cannot use either a bank cEMV card or a mobile phone. So it will be some time before dedicated transport tokens will disappear entirely.

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<sup>15</sup> Source: County Council.

<sup>16</sup> Source: County Council.

<sup>17</sup> <https://cambridgedialaride.org.uk/>

<sup>18</sup> Sources: Operator websites.

### 3.3.8 Fares

Currently each operator can set their own fares, and for perceived competition reasons are reluctant to share these. Multi-bus fares are set by negotiation between the operators and the Council and increased by the rate of inflation annually<sup>19</sup>. This situation may be a fact of life currently, but it is not conducive to fully open, multi-operator, multi-modal, competitive public service travel in Cambridgeshire. Without a comprehensive agreement on fares, subject to the Competition and Marketing Authorities Block Exemption for Public Transport, the target of Best Fare for all travel will not be achieved.

However, should a bus quality partnership or franchising system be put in place, then the local authority will be able to exert more control over fares.

## 3.4 Current Heavy Rail Provision

### 3.4.1 General Ticket Sales Provision

All the Train Operating Companies (TOCs) listed below provide ticket sales at stations (ticket office and / or ticket vending machines) and via the Internet. Additional sales channels provided by each company are listed below.

The DfT are pushing TOCs to retire traditional “tangerine” tickets in favour of barcode and ITSO smart tickets. Barcode tickets may be printed on low cost thermal paper, displayed as tickets on mobile phones or printed at home. Gates are being upgraded with barcode readers enabling automatic ticket validation.<sup>20</sup>

### 3.4.2 Abellio Greater Anglia (AGA)<sup>21</sup>

Abellio operate services from Cambridge to London; Norwich; Stansted Airport; Ipswich and other local destinations within Greater Cambridge and East Anglia.

An ITSO smartcard is provided, supporting season, single and return tickets. All AGA stations are now ITSO equipped with either gates or validators. However not all journey flows are yet enabled pending integration with Thameslink/Great Northern.

They provide a mobile phone app. for ticket purchase.

AGA are rolling out barcode ticketing, with gates barcode fitted already. On-train sales are already using barcodes printed on thermal paper, and AGA have a plan to convert ticket office machines to this technology. They are discussing converting ticket vending machines to the technology but have not yet reached agreement with the supplier Scheidt & Bachmann.

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<sup>19</sup> Source: County Council.

<sup>20</sup> Source: GA telephone interview.

<sup>21</sup> Source: TOC Website, GA telephone interview.

### 3.4.3 GoVia Thameslink Including Great Northern (GTR)<sup>22</sup>

Great Northern & Thameslink operate services from Cambridge to London; Kings Lynn; Ely and local stations in the Greater Cambridge area and East Anglia, including an express service to London.

“The Key” ITSO smartcard is available on Thameslink and Great Northern (between London and Huntingdon & Foxton) for season ticket holders and “KeyGo” pay as you go customers. Single and return tickets are also available from ticket vending machines at some stations outside London. Greater Cambridge stations where “The Key” can be used are Foxton, Meldreth and Shepreth, but not Cambridge or Cambridge North.

They provide a mobile phone app. for ticket purchase, and are assumed to be rolling out barcode ticketing.

### 3.4.4 Cross Country<sup>23</sup>

Cross Country run services from Cambridge to Birmingham and Stansted Airport.

They provide a mobile phone app. for ticket purchase.

### 3.4.5 Summary of Heavy Rail Ticketing

Table 5 excludes the standard tangerine paper ticket with magnetic stripe which the DfT, RDG and operators wish to phase out subject to cost of change and the acceptability of the alternative. At the present time the “tangerine” tickets are the only nationally accepted interoperable rail ticket, including acceptance on Transport for London services.

Operator	Ticketing technology			Current Interoperability		Smart tickets
	Barcode	ITSO	Mobile	Rail to rail (See note 1)	Rail to bus	ITSO
Abellio Greater Anglia	Yes, compliant with the RSP Standard	Yes	Yes, compliant with the RSP Standard (Note 1)	Limited	Plusbus (paper)	Seasons, singles and returns
GoVia Thameslink & Great Northern	Rollout Assumed	Yes	Yes (Note 1)	Limited	Plusbus (paper)	Seasons and pay as you go
Cross Country	Yes (print @ home tickets) <sup>24</sup>	No	Yes (Note 1)	Limited	Plusbus (paper)	N/A

Table 5 - Summary of Heavy Rail Ticketing

Note 1: rail to rail interoperability

- ITSO and Barcodes are in process of being rolled out, so tickets in these formats are currently only available on some routes. The plan is to equip all stations so that these formats can be used throughout the UK.
- There is a rail standard for mobile phone apps using barcode validation, however, these companies’ apps may not yet be updated to this standard, limiting interoperability.

<sup>22</sup> Source: TOC Website

<sup>23</sup> Source: TOC Website.

<sup>24</sup> Source: the author’s personal experience using Cross Country services.

Station Name	AFC Provision				Owner
	ITSO?	Barcode?	Gates?	Validators?	
Cambridge	Yes	Yes	Yes	No	AGA
Cambridge North	Yes	Yes	Yes	No	AGA
Foxton	Yes	No	No	ITSO	GTR
Meldreth	Yes	No	No	ITSO	GTR
Shelford	Yes	No	No	ITSO	AGA
Shepreth	Yes	No	No	ITSO	GTR
Waterbeach	Yes	No	No	ITSO	GTR
Whittlesford	Yes	No	No	ITSO	AGA

Table 6 - Summary of Greater Cambridge Station Ownership and AFC Provision

### 3.5 Other Modes of travel<sup>25</sup>

#### 3.5.1 Taxi & Private Hire

As well as regular taxis and private hire, app -based ride hailing services including Uber and Taxicode operate in Cambridge.

#### 3.5.2 Bike Hire

OFO ran a dockless bike hire scheme in Cambridge but have now withdrawn the service. Mobike still operate in the city although in a constrained geography.

There are apparently numerous small outlets offering bike hire in the city.

#### 3.5.3 Ride Sharing

Internet based ride sharing services, such as liftshare, cover the Cambridge area.

#### 3.5.4 Car Clubs

Zip Car and Enterprise offer car club services in Cambridge. These are essentially subscription services, and whilst they may find a place in a MaaS service, are not likely to be part of an integrated ticketing scheme because they are not public transport.

### 3.6 Future plans

Because public transport services already operate in Cambridgeshire and its environs, it is not possible to start from scratch when attempting to create a passenger friendly integrated ticketing system. Today we have legacy systems and organisations with no design for a future integrated environment that is acceptable to all players.

This study makes a start in this direction; it takes note of the context of the current environment and any plans already in progress. The following paragraphs highlight those that we know of.

#### 3.6.1 Cambridge Autonomous Metro (CAM)

<sup>25</sup> Source: Internet.

The Combined Authority (CA) is working up a case for a metro system for Cambridge. The exact form which this will take is not yet decided: tram; light rail; rubber-tyred metro and bus have all been suggested. It is proposed that the metro crosses the city centre in tunnels.

### 3.6.2 Future Bus

Two new busways are proposed, Cambourne to Cambridge and the other to the south towards Haverhill. No other specific new bus routes have been identified, however because of extensive housing development in the Greater Cambridge area it is assumed that new routes will be established in due course.

The Combined Authority (CA) is considering the case for either an enhanced bus partnership or bus franchising. A partnership could give the CA more control over fares and ticketing, and franchising should allow absolute control.

### 3.6.3 Future Rail

Future rail projects include:

- A new Cambridge South rail station;
- Heavy rail to Bedford, Milton Keynes and Oxford, with improved services to Norwich and Ipswich (The East-West line); and
- Reopening the Wisbech rail branch (outside the Greater Cambridge area).

### 3.6.4 Proposed Rail Fare Reform<sup>26</sup>

The following two sub-sections are set down in order to provide a complete picture of what heavy rail is considering.

In February 2019 the Rail Delivery Group (RDG) published a report on proposed rail fare reform. This proposal is based on a public consultation conducted jointly by RDG, Transport Focus and Systra. KPMG were retained to conduct economic analysis and commercial modelling.

The report indicates that consultees wanted: “value-for-money and flexibility; an easy to understand offer; tickets which are easy to buy; greater personalisation; protections maintained and redress if things go wrong; a system which reflects national and local needs; and, a sense of trust and confidence in the tickets they’re buying”. The report adds that this needs to be balanced with: “the need for fares to generate revenue”; “the need for operators to be able to manage prices to respond to their markets and reduce crowding by spreading demand”; and “the need for local and regional authorities to be able to manage transport as part of integrated transport systems”.

The core proposition is that “customers should only pay for the travel they need, and the system is designed to give them the best value fare”.

The report forms one part of the rail industries submission to the Williams Review of UK rail. A two-stage approach is proposed:

- Stage one - “Industry and government work together to reform the way that fares are worked out. This means government replacing the outdated Ticketing and Settlement Agreement (TSA) with a new set of system regulations”;

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<sup>26</sup> Source: RDG / Transport Focus report and RDG press release, <https://www.raildeliverygroup.com/media-centre/press-releases/2019/469762745-2019-02-18.html>.

- Stage two – “with these new system regulations in place commercial changes will then need to be agreed with operators, reflecting in new pricing regulations written into their government contracts”.

Commercial trials are proposed which “would give customers more opportunity for engagement with the proposed changes”. In the words of Anthony Smith, chief executive of Transport Focus: “at this stage, it is hard to work out the precise implications of these proposals” and “it will be some time before these are known”. He believes that the trials are “essential”.

The changes proposed would enable:

- The ‘unbundling’ of fares, thorough a move to a single fare as the basic unit of pricing, with algorithmic rules underpinned by regulation to encourage the best combination of single fares for return, through and multi-journey tickets. The capability to buy a ticket from any station to any other station, regardless of operator, would be maintained.
- Train companies would be able to create discounted, premium, train specific and personalised variations of these fares.
- Protection from excessive fares through regulation of price levels rather than of a limited number of specific fare types. The example given is moving from regulating day returns and 7-day season tickets, to regulating the maximum price paid when travelling over the course of a week, with systems programmed to deliver this automatically.

The press release claims that these reforms would support unlocking the full potential of new ticketing technology; enable ‘tap-in, tap-out’ pay as you go to be rolled out across the country; enable greater local control over fares in devolved areas and better integration of rail fares with those for other modes of transport.

### 3.6.5 Rail Pay as you Go Ticketing for South East England<sup>27</sup>

DfT are consulting on creating a new pay-as-you-go (PAYG) zone for rail travel in the south east of England. This it is suggested could be “just a first step, and we will continue to work with other areas to assess opportunities to roll-out PAYG”. With respect to Cambridge, the proposed scheme boundary is Stansted Airport, however possible expansion to a boundary at Cambridge is mentioned.

No decisions have been made on technology, however DfT say that “it is likely that TfL’s contactless bank card system would play a part”. Fares could also be restructured: options suggested include changing the way single and return prices are set so that a return journey costs the same as two singles. Alternatively, it’s suggested that a zonal fares structure is also possible, involving significant ticket price changes. The source indicates that DfT has no intention of withdrawing paper tickets.

### 3.6.6 Mobility as a Service (MaaS)<sup>28</sup>

This section records current Council engagement with MaaS providers. Please see section 0 for more information.

**MaaS Global** (MaaS provider)

<sup>27</sup> Source: Local Transport Today

<sup>28</sup> Source: County Council

After discussions with MaaS Global, it had been intended to implement a service, based around the bio-medical campus, last October, but as yet it has not commenced. Implementation timescales are currently unclear.

### 3.7 Contextual summary

Currently there is no integrated ticketing in the Greater Cambridge area, other than the bus only Multibus season ticket, PlusBus and rail inter-available tickets.

Smart ticketing is to some extent implemented, but is disjointed, with disparate schemes which do not interoperate, despite all being based on ITSO technology.

Rail have a standard for barcode tickets for use with both paper tickets and mobile phones, however buses do not use this standard in their mobile apps. Therefore, to achieve interoperability with mobile phone apps, the bus operators would have to redesign or replace their existing apps with rail compatible versions. They would probably require financial assistance with the capital costs involved.

ITSO on mobile may provide a solution to interoperability of mobile phone apps, however it's likely that both bus and rail operators would have to redesign their existing mobile app offering, again incurring capital cost, unless a common app was developed for the Greater Cambridge area.

Rail fares reforms and rail pay-as-you-go are both an opportunity and a threat. Fare reform should, all being well, make it easier to implement smart ticketing schemes, that being one of the primary drivers for the project. However, implementation will be slow, waiting for the Williams review and a government white paper (both promised for later this year) before the way forward will be known. Renegotiating the Ticketing and Settlement agreement will be time consuming, following which there will be the further time-consuming process of designing and implementing a new revenue neutral fares scheme. Therefore, implementation of reformed fares could take longer than the Council might wish, potentially delaying implementation of integrated ticketing in Greater Cambridge.

The proposed pay-as-you-go scheme, should it reach Cambridge, may simplify implementation of integrated ticketing by providing local reform of rail fares. It is suggested that this may become one of the rail reform trial projects. However, implementation could conflict with the Council's integrated ticketing project in that: rail companies will have two schemes to implement at roughly the same time; customers will be confused as to which to use; and there may be technical or commercial conflicts between the two schemes.

All in all, these developments in rail ticketing should be welcomed, and the risks managed to ensure that the benefits can be realised.

Taxi's, private hire, car clubs and lift sharing may have a place in handling the first and last mile problem but to date there have been no moves to integrate public and private transport schemes at the ticketing level. A MaaS scheme would demand such integration but this could initially be at a higher level with the MaaS service offering an integrated appearance to travellers while underneath the skin emulating each individual operator's ticket purchase.

## 4. Technical options for delivering an integrated ticketing scheme

## 4.1 Ticketing Token Technologies

### 4.1.1 Paper Tickets – Visually Validated

Visually validated paper tickets are the traditional ticketing method worldwide and are still very widely used for bus tickets. They are very prone to fraud and misuse relying as they do on visual inspection, particularly so for high value tickets. They can be used in an integrated ticketing environment such as the numerous multi-operator bus ticket schemes. However, because they cannot be validated automatically, they are unsuited for gated rail and metro systems.

### 4.1.2 Paper Tickets – Validated with a Barcode or Magnetic Coding

Paper tickets with printed barcodes support automated validation as well as visual inspection and are being introduced by the UK rail industry as a replacement for the standard tangerine ticket. The latter have a magnetic strip allowing automated validation as well as visual inspection. However, rail's ambition to move to barcode tickets suffered a setback when TfL refused to accept them on the basis that validation speed was too slow. This has a serious interoperability impact – currently cross London rail journeys are facilitated by use of the London Underground, with a single tangerine ticket coded magnetically to allow validation by TfL's gates. Tangerine tickets are therefore retained for the time being.

Both types of ticket, because they can be validated automatically, are much more suited to multi-modal schemes. However, both suffer from disadvantages: barcode tickets are relatively slow to validate; and magnetic validation systems are expensive to procure and to maintain. For these reasons' some operators (e.g. TfL) have either declined to implement them or are attempting to phase them out.

All paper tickets suffer from lack of durability and ease of fraud, and current thinking is to phase them out in favour of better solutions.

### 4.1.3 Smartcards

ITSO is the UK national specification for transport smartcards. Because it is used for statutory concessionary smartcards in England, Scotland and Wales, the vast majority of service buses are now equipped to validate these cards. Furthermore, national rail is rolling out equipment to issue and validate rail tickets encoded in ITSO smartcards. Therefore, due to the widespread availability of terminals supporting it, ITSO is recommended as the technology standard should Cambridgeshire opt for a smartcard-based ticketing scheme.

Other smartcard formats are available, including suppliers' proprietary systems and other specifications used elsewhere in the world. These are not recommended for use in the UK because significant investment would be required to upgrade or replace equipment to accept an alternative system and supplier's systems are not interoperable between suppliers.

The original rationale for ITSO was to avoid the situation where operators had to support multiple smartcard formats, possibly using multiple card readers. Taking Oyster as an example, because it uses a single suppliers proprietary card format, gates, ETMs and validators in the London area have had to be upgraded to support ITSO, Oyster, and contactless bank cards, as well as rail standard magnetically encoded tickets, and in the case of rail validators, barcode tickets. Consequently, there is a significant cost penalty.

Smartcard tickets can take several forms:



- Season tickets have been rolled out by rail and major bus companies;
- Single trip, return and carnet tickets are all practical;
- A pre-paid electronic purse has been rolled out in London (Oyster), and also using ITSO in Nottingham, for example, and again in the West Midlands;
- The smartcard can act as a token for an account-based scheme.

#### 4.1.4 Contactless Bank Cards (cEMV)

Contactless bank cards have become the current payment method of choice for low value transactions. In March this year the BBC reported that 40% of all card payments are contactless, and that contactless payment rose 31% in 2018 compared to 2017<sup>29</sup>. Also in March this year National Express West Midlands reported that up to 50% of payments are contactless on some of its bus routes<sup>30</sup>

The UK Cards Association has defined 3 operating models:

- Model 1 – simple cash replacement, the fare is known at the time of purchase and the card is used in place of cash. Typically, a paper ticket is issued. This method is rapidly being rolled out across all UK public transport;
- Model 2 – Complex cash replacement, where the fares for one or more journeys are aggregated typically at the end of day, and a single charge made to the card. This method has been rolled out across London and is an early example of account-based ticketing;
- Model 3 – Ticket pre-purchase, where the card used for payment is also used as a form of identity to travel. This method has been seen as a solution for long distance rail travel but has not yet been implemented.

cEMV is very attractive as a transit payment method, but it should be noted that not everybody qualifies for a suitable credit or bank account, and some qualifying people will not use such a system. Therefore, for the foreseeable future alternatives must be provided, unless the transit authority is capable of issuing suitable cEMV cards itself, probably under its own brand. For an ABT system, the card need not be a bank card, just using the same interface as bank cards. The terminals and back office would recognise that it's a local card rather than a bank card, and treat it as a token, but not a payment instrument. The authors are currently unaware of any scheme which has done this.

Another restriction with cEMV bank cards is that payment value is currently limited to £30.00, as a fraud risk mitigation measure.

Therefore, cEMV on its own is currently unsuitable for an integrated ticketing system but will be one useful element of such a scheme.

A concern with cEMV is that there is no defined standard for communications between payment terminals and the Payment Service Provider (PSP) who processes transactions. In practice each payment terminal provider has integrated with one PSP using a bespoke interface. There is therefore a risk that additional cost could be incurred either developing a new communications interface between terminal types and a PSP, or alternatively in integrating the activities of the various PSPs.

#### Private Label cEMV Cards

<sup>29</sup> <https://www.bbc.co.uk/news/business-47581707>

<sup>30</sup> <https://www.intelligenttransport.com/transport-articles/76309/contactless-cards-national-express-wmidlands/>

These cards use the cEMV interface protocols but are not bank issued cards. They can be issued by non-banking organisations as a form of identity token for ABT schemes which also use bank cards. They would be useful for those customers who cannot or will not use a bank card or mobile phone for ticketing. In the longer term this approach may come to replace earlier forms of smart ticketing, the advantage being that only a single token – reader interface protocol need be supported.

#### 4.1.5 Mobile phones

##### Proprietary Apps

There are a number of proprietary applications provided by start-up companies. Originally these all relied on visual inspection of tickets, although automatic validation using barcodes or Near Field Communications (NFC) is possible. Apps can be implemented in a number of forms:

- Proprietary apps which are used for travel planning and ticket purchase with either visual or barcode-based validation. Examples include the “first generation” apps used by bus and rail companies;
- Pre-purchased tickets stored in a wallet, e.g. Applepay or Googlepay, using the NFC standard to communicate with terminals; and
- Bank card details also stored in a wallet, e.g. Applepay or Googlepay, using the NFC standard to communicate with terminals.

Typically, different suppliers’ apps are not interoperable with each other, and therefore are not suitable for an integrated ticketing scheme, unless all operators use the same app.

##### UK National Rail Standard

An exception to the current problems in achieving interoperability is UK national rail, where the Rail Delivery Group has produced a standard for barcode ticketing. This standard is used for both printed paper and mobile phone tickets and although there are a number of suppliers, use of the standard provides interoperability across the rail network. If bus companies can be persuaded to use the same standard, then multi-modal interoperability is a possibility.

Most modern ETMs can support a barcode reader, although few are currently fitted, and the upgrade would involve capital cost. However, the primary concern with using barcodes is validation speed, which is slower than other forms of automatic validation.

##### ITSO on Mobile<sup>31</sup>

Two services have recently been developed, offering mobile apps compatible with the ITSO infrastructure. This means that they will communicate with ITSO readers in the same way as an ITSO compliant smartcard, without any need to modify the reader. They use the Near Field Communications (NFC) standard to communicate with external devices such as transit gates. This standard is compatible with the ISO/IEC 14443 standard used for smartcards, hence compatibility with ITSO readers is achieved.

ITSO Transit Hub Ltd.<sup>32</sup> This service has been developed by the ITSO organisation and is now in the process of being spun out into a separate organisation. An app which can be customised, and a back

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<sup>31</sup> Source: ITSO Operations Advisory Group (OAG)

<sup>32</sup> Sources: ITSO OAG and ITSO interview.

office are provided, giving a complete service. The service is currently being trialled on the West Midlands Metro as part of the Swift multi-operator ticket scheme.

Rambus<sup>33</sup> (formally ECEBS) have developed a similar service, which it is understood is currently being trialled on the Glasgow Subway. Again, a customisable app and back office are offered, providing a complete service.

Both these services use the Google wallet service restricting them to Android phones and will need further development work to operate on Apple phones.

There are advantages to ITSO compatibility:

- Use of the NFC secure communications mechanism is more secure than barcodes and allows two-way communication with terminals;
- Compatibility with the ITSO infrastructure means no infrastructure change<sup>34</sup> is required, i.e. there is no need to modify existing equipment or procure new terminals both of which would involve significant capital cost.

### **Mobile phones using non-ITSO NFC**

These will not communicate with the existing ITSO infrastructure, and therefore are not applicable to use in the short to medium term primarily because of the high infrastructure capital cost required.

### **Mobile Phone Platforms – NFC Restrictions**

Currently not all phones support the open use of the NFC interface by apps. Most recent Android phones sold in the UK support NFC, and the ITSO and Rambus solutions are limited to these. As at the time of writing, Apple do not permit open use of the NFC interface, although there are signs that they may relax this policy.

### **Other Restrictions**

Not all passengers have suitable mobile phones, or if they have them, they are not prepared to use them for ticketing. Therefore, for the foreseeable future alternatives must be provided.

### **Integrated Ticketing Potential**

Mobile phones clearly have a role to play and are likely to be a major component of future ticketing schemes. Their advantage is their flexibility in that they can be used to plan journeys, choose and pay for tickets, check real time travel information, validate tickets when required, and check remaining validity, e.g. pass expiry date or carnet rides remaining. Today, the technologies most suited to an integrated ticketing scheme are barcode validation based on the rail industry standard, although this cannot be used in the London area, and ITSO on mobile which can be used anywhere ITSO is supported.

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<sup>33</sup> Sources: ITSO OAG and Rambus interview.

<sup>34</sup> It should be noted that the latest version of ISAM (V3) is required, and if older versions are still in service they need to be replaced.

## **Use as a “load terminal”**

NFC capable mobile phones can also be used as “load terminals” in smartcard schemes. Tickets and top ups purchased on-line are sent to an app in the mobile phone, and then downloaded into the smartcard using the NFC interface. This approach is likely to be superseded by an ITSO on Mobile capability and service, in which the smartcard can be discarded, and the mobile phone communicates directly with ITSO readers.

## **4.2 Operational Methods**

### **4.2.1 Smart Ticketing System Architectures**

#### **Media based ticketing**

These systems are ones where tickets are stored in a ticketing media carried by the passenger. the ticketing media can be a smartcard, smart device or a mobile phone. A typical example is an ITSO smartcard.

#### **Account based ticketing (ABT)**

Each customer has an account with the transit authority and holds an electronic token which associates them with the account. The token is used as authority to travel and is presented to a transit terminal at commencement and again at the end of a journey. Tokens can be, for example, a smartcard, cEMV card, mobile phone app, a simple RfID tag, or a card with a printed barcode. To date implemented schemes have used cEMV cards (and cEMV compatible mobile phone wallets) as both the token and the payment method.

Supporting multiple token types is advantageous in that all customer types including those who cannot use a bank card can be supported, not just cEMV card holders. In due course concessionary passes could be included in a multi-token ABT scheme where a cheaper token could reduce concessionary scheme costs, although this would imply a nationwide ABT scheme. Adopting a multi-token scheme from the outset may require more up-front capital, but is future proof and avoids the risk of requiring multiple systems to support different token types as well as expensive downstream system upgrades.

Accounts can be opened automatically when a cEMV card is used as the token, allowing the customer to remain anonymous but still giving them the option to register if they wish to do so. TfL’s contactless scheme works in this way. When other tokens are involved, pre-registration is necessary which may be less convenient for passengers.

Potentially all types of ticket and payment method can be supported by an ABT system and this therefore should be the goal as it maximises benefits from the scheme and avoids providing different systems for different ticket types. Both pre-payment (e.g. an e-purse equivalent) and post-payment options are theoretically available.

The leading single cEMV token ABT system implemented to date is TfL’s system implemented in London and is licenced to Cubic. It has now been sold to a number of major cities world-wide. Alternative suppliers are beginning to come on stream, including INIT and ACT. The authors understand that Unicard are also developing a system.

#### 4.2.2 Payment options

##### **Pay on Departure**

Customer pays at journey commencement, e.g. to the bus driver or at a railway station.

##### **Pre-purchase**

Customer pays in advance, e.g. internet or mobile phone app purchase. For example, season tickets, rail tickets purchased on-line. Tickets may be fulfilled to a mobile phone app; to a smartcard via an action list enabling collection at a terminal; to a rail magnetic ticket via the rail industries 'ticket on departure' mechanism, or "printed at home".

##### **Pay as you go**

The customer pays for travel as they use it, either from a purse or fares are charged to an account. Examples include TfL's Oyster card and "Contactless" payment schemes.

##### **Pay post travel**

The customer or organisation opens an account with the transit authority, and pays periodically for all travel used, e.g. weekly or monthly. A good example is corporate travel accounts. This method could be offered with account-based ticketing.

##### **Payment Risks**

With ABT schemes the scheme operator's risk is increased because customer payment default won't be detected prior to travel. Payment default risk mitigation relies on prompt system responses to the default, so that the customer can be stopped at the end of their journey, or failing that before they make further journeys. Additionally, pre-paid account tokens can be hotlisted when there are insufficient funds available for travel, thereby eliminating default risk.

#### 4.2.3 Advanced Ticketing Methods

##### **Fare Capping (Best Fare calculation)**

A technique usually implemented alongside a pay as you go scheme. When a customer makes multiple journeys over a predefined timeframe, the maximum fare they pay is capped. The cap is frequently equal to the cost of a season ticket for the same timeframe. This technique can be implemented with both ITSO smartcards and account-based ticketing and is implemented on both Oyster and TfL's "contactless" pay as you go schemes.

### **Touch in – Touch out (TiTo)**

The customer presents a token at both the commencement and the end of their journey. The system works out the correct fare for the journey made after journey completion and charges the customer appropriately. Examples include TfL's Oyster and "Contactless" schemes. This type of scheme can be implemented with a smartcard based electronic purse (Oyster) or with an account-based scheme (e.g. TfL's Contactless scheme).

Costs are increased because additional touch in / touch out terminals are typically required, except where rail station ticket validation gates are in use.

### **Be in – Be out (BiBo)**

An extension of TiTo where minimal customer action is needed. A token held by the customer is interrogated wirelessly by beacons on-vehicle, and the customer's account debited for the appropriate fare.

Trial implementations to date have been based around mobile phones and the Bluetooth Low Energy (BLE) communications standard. In the longer term this is an ideal method, eliminating transit gates and reducing queuing and customer inconvenience, but to date only trials have taken place. One disadvantage is that customers must have a suitable mobile phone with the relevant app loaded, therefore for the time being other ticketing methods must also be in place. There are also concerns regarding fare avoidance and ticketless travel, which need to be resolved prior to widespread implementation.

### 4.3 Technology Support for Operational Techniques

Technology	Method							
	Pay on Departure	Pre-Purchase	Pay as you Go	Pay post travel	Fare Capping	TiTo	BiBo	ABT
Paper – visual validation	✓	✓						
Paper – Barcode validation	✓	✓						
Paper - magnetic validation	✓	✓						
ITSO Smartcard	✓	✓	✓	✓	✓	✓		✓
cEMV Model 1	✓							
cEMV Model 2			✓	✓	✓	✓		✓
cEMV Model 3	✓	✓						
Mobile Phone - visual		✓						
Mobile Phone – Barcode		✓						
Mobile Phone – non-ITSO NFC		✓	✓	✓	✓	✓		✓
Mobile Phone – ITSO NFC		✓	✓	✓	✓	✓		✓
Mobile Phone - BLE <sup>35</sup>							✓	

Table 7 - Technology Support for Operational Techniques

<sup>35</sup> Blue Tooth Low Energy (communications standard)

#### 4.4 Ticketing Scheme Use Cases, Past Present and Future

The following table summarises the smart ticketing use cases. Cash and Paper use cases are ignored, because these methods cannot be considered to be integrated ticketing.

	Case 1	Case 2	Case 3	Case 4	Case 5
Description	Smartcard based	Mobile Phone App.	cEMV M1 cash replacement	cEMV M2 pay as you go ABT	Multi-Token ABT
Example	Swift	Bus Fare App	Bus ticket purchase	Underground	Future
<b>Architecture</b>					
Card / phone centric	✓	✓	✓		
Account Based				✓	✓
ITSO	✓	✓ <sup>36</sup>			✓
<b>Tokens</b>					
cEMV Model 1			✓		
cEMV Model 2				✓	✓
Transit card	✓				✓
Mobile phone emulating transit card		✓ <sup>37</sup>			✓
Mobile phone emulating cEMV card			✓	✓	✓
Mobile phone with proprietary epurse			✓	✓	✓
Id token					✓
<b>Products</b>					
Flat fare	✓	✓	✓	✓	✓
PAYG	✓	✓ <sup>38</sup>		✓	✓
Season ticket	✓	✓	✓		✓
Carnet	✓	✓	✓		✓
Single & return tickets	✓	✓	✓		✓

Table 8 - Smart Ticketing Use Cases

Note that cEMV model 3 is not included, because whilst a form of ABT it's essentially a pre-pay technology and does not meet the requirements for integrated ticketing in Greater Cambridge.

<sup>36</sup> Only if "ITSO on Mobile" technology used.

<sup>37</sup> Only if "ITSO on Mobile" technology used.

<sup>38</sup> Only if "ITSO on Mobile" technology used.



## 4.5 Technology roadmap

The foregoing sections lead us to believe that the short to medium roadmap is as follows. The longer-term roadmap can be found in section 6.6. Note that this diagram covers technology availability, not scheme timelines, which are covered in section 5.


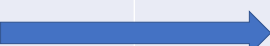

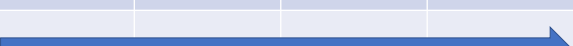

Technology Availability	Technologies	Year 0	Year 1	Year 3	Year 7	Year 10+
Mature & readily available	Cash, Paper, ITSO Smartcard, cEMV Model 1 cash replacement, mobile phone apps, TITo					
Coming on stream now	Rail Barcode (paper & mobile), rail ITSO smartcard, ABT based on cEMV Model 2					
Available in the short term, 1 – 3 years	ITSO on Mobile, Multi-token ABT					
Available in the medium term, 3 – 7 years	Pre-purchase using cEMV model 3					
Available in the long term	BiBo					

Figure 2 - Short To Medium Term Technology Roadmap

## 5. Analysis of Scheme Options

This section looks at each scheme option in some detail, identifying opportunities and relative benefits; barriers and relative disbenefits, and the value of each option to integrated ticketing. For those judged worthwhile, indicative costs at 2018 prices and outline timescales have been produced.

Note that firm costs and timescales can only be determined by conducting a procurement exercise and the costs provided here are indicative only, i.e. rough order of magnitude (ROM) costs. In our estimates for both costs and timescales we have assumed that a prompt start will be made, all initial pre-implementation project tasks be completed (e.g. business rules specification), and that there will be no delays in the commencement and execution of the project, noting that delays inevitably increase costs. Our experience from many projects is that it is very easy to let projects slip when focus is not maintained on achieving every task on time, and that in over 90% of cases lost time cannot be recovered leading to delayed delivery compared with the original plan.

The technology used for automatic fare collection, and the way in which systems are provided is currently in a state of flux. There is a move from paper to smart ticketing, and from card-based schemes to contactless bank cards and account-based ticketing (ABT). At the same time back office system provision is moving from expensive bespoke systems to 'off the shelf' systems provided as a managed service. For examples HOPS and the associated customer management systems, and the Ticketer ETM back office, are all provided as managed services. ACT have recently launched settlement and ABT back offices as managed services. It is not yet clear whether ABT and off the shelf managed service systems will be sufficiently mature for use by the Council in the next two to three years. This uncertainty makes providing costings for some system elements very difficult.

Another factor affecting both costs and timescales is the method by which the project is taken forward, for which there are a number of options. One option is to adopt a packaged solution from a single supplier, where the supplier assumes (and charges for) all the technical and project risk. Alternatively, where a number of suppliers are contracted to provide various system elements, these need to be integrated so that the entire scheme works coherently as a whole. This is not so difficult today as it may sound, as most suppliers are used to having to work with others and provide communications interfaces for this purpose. A third-party system integrator could be employed, alternatively a 'do it yourself' approach has been successfully employed by a number of schemes, notably Yorcard and Swift. In the latter case the client takes the technical and project risk reducing costs, mitigating this risk by employing external expert consultants to assist with project management and technical integration.

Choosing off the shelf systems can reduce costs, that is buying systems which the suppliers have already developed. Alternatively, bespoke systems can be very expensive. Excessive cost can be avoided by resisting the temptation to specify 'nice to have' features which are not currently provided by suppliers.

The following subsections are aimed at looking at scheme options; however, schemes are defined by the services they support which in turn are created as an amalgam of functions often requiring the use of specific technologies. For this reason, our detailed analysis of options also looks at the scheme's underlying constituent parts.

## 5.1 Basic Options

### 5.1.1 Simple cash + paper

This is the current base ticketing scheme; all ticket types are supported except pay as you go.

#### Opportunities and relative benefits

- Universally supported.

#### Barriers and relative disbenefits

- Very limited support for multi-leg tickets, e.g. a journey comprising of an initial bus leg followed by a rail leg. This is because:
  - o Bus operators typically can only sell tickets to destinations on the current route, doing otherwise is technically very complex;
  - o Bus operators do not currently have access to each other's fares; and
  - o Rail ticket retailers are currently required to sell all types of inter-available ticket to all destinations on the network, which is prohibitively difficult to do on bus.
- Best Fare calculation for successive journeys is impractical;
- Recording of multi-operator ticket usage is haphazard, relying on manual recording by drivers. Settlement between operators is therefore often based on statistical methods, or avoided with revenue 'lying where it falls';
- There are substantial cash handling costs.

#### Value in an integrated ticketing scheme

- Low: Difficult to accommodate multi-leg journeys and provision of "best fare" is not practical.

#### Indicative investment costs (for those options which do not fail on other criteria)

There are no investment costs involved, since the systems are already in place.

#### Potential delivery timescales (for those options which do not fail on other criteria)

Systems are already in place; no investment is required.

### 5.1.2 cEMV Cash Replacement

Tickets are pre-purchased typically at the time of departure using a contactless bank card. This is the system currently being deployed on bus and at rail stations, with substantial coverage already. Known as cEMV model 1, all ticket types except pay as you go are supported.

Whilst upgrading the Greater Cambridge small bus operators to accept cEMV payments it makes sense to enable ITSO on their ETMs at the same time. This will enable electronic acceptance of ENCTS and hot listing lost and stolen cards, and is a stepping stone towards use of ITSO cards as an ABT token in the full scheme. In the cost estimates it is assumed that the Council's existing ITSO HOPS will be used for the small operators.

An alternative also using cEMV model 1, is flat fare payment at an on-bus validator or railway station gate.

### **Opportunities and relative benefits**

- cEMV is rapidly becoming accepted as a major method of payment for small purchases.;
- Convenient for passengers, no need to find change;
- Convenient for operators, reduced cash handling, avoids need to give change therefore potentially improving dwell times;
- Stagecoach bus and national rail are already equipped, and Whippet are moving in this direction;
- The full range of ticket types are supported;
- The costs of smartcard issuing are avoided when the passenger uses a bank issued card.

### **Barriers and relative disbenefits**

- Some customers will not use contactless cards, for one reason or another, although the proportion will decrease over time. Additionally, some customers do not qualify for a bank account, and therefore cannot obtain a contactless card. Therefore an alternative method must be made available;
- Very limited support for multi-leg tickets, e.g. a journey comprising of an initial bus leg followed by a rail leg. This is because:
  - o Bus operators typically can only sell tickets to destinations on the current route;
  - o Bus operators do not currently have access to each other's fares; and
  - o Rail ticket retailers are currently required to sell all types of inter-available ticket to all destinations on the network, which is prohibitively difficult to do on bus.
- Best Fare calculation for successive journeys is impractical;
- Financial clearing costs may increase;
- Risk that technology will be discredited due to fraud – stolen cards can be used to make purchases because no pin is required. Currently convenience and financial industry profits are overcoming the fraud costs, however excessive fraud levels could undermine this view.
- Each card can only be used contactless 10 times in succession without needing to enter a pin – which is not possible with on-bus equipment;
- There is a £30 transaction value limit, so cEMV cannot be used for higher value tickets;
- Not currently supported by Whippet and the small bus operators, however Whippet are looking at upgrading.

### **Value in an integrated ticketing scheme**

- Low: cEMV Model 1 is essentially a replacement payment mechanism, replacing cash. As such it offers no integration advantages over and above cash payment.

### Indicative investment ROM<sup>39</sup> costs

Item	ROM Cost
Business case	£190,000.00
Small operators upgrade	£260,000.00
cEMV set up	£20,000.00
Project management, Technical consultancy & testing	£70,000.00
Marketing	£40,000.00
<b>TOTAL</b>	<b>£600,000.00</b>

Table 9 – Up-front ROM Costs for cEMV cash replacement throughout Greater Cambridgeshire

Note that these estimates assume that Whippet will self-fund their ETM upgrade to support cEMV and ITSO commercial cards.

### Indicative operational expenditure ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
cEMV costs	£40,000
Support person	£35,000
<b>TOTAL</b>	<b>£110,000</b>

Table 10 – Operational ROM Costs for cEMV cash replacement throughout Greater Cambridgeshire

### Potential delivery timescales

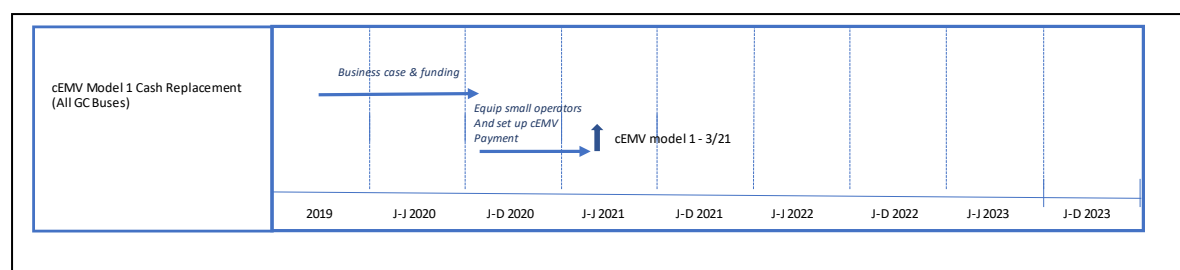


Figure 3 – Potential Delivery Timescales for cEMV cash replacement throughout Greater Cambridgeshire

<sup>39</sup> Rough Order of Magnitude

## 5.2 Smartcard ticketing schemes

Smartcard based ticketing schemes have been around for over 20 years, with numerous examples worldwide. They can be used for any ticket type, including pay as you go with capping. ITSO is the standard for the UK, examples include the West Midlands (Swift), Nottingham (Robin Hood card), West Yorkshire (Metro Card), South Yorkshire (Travel Master), Stagecoach's Megarider products, and of course London's Oyster.

The scheme described here does not include a mobile phone app, for this see section 5.4.

### Opportunities and relative benefits

- Widely available and proven from a number of suppliers;
- The full range of ticket types is supported;
- Backed by the UK standard for interoperability (ITSO);
- Already installed at larger bus operators and currently being rolled out at rail operators;
- ITSO cards are multi-application, meaning that several operators products could be placed on a single card, irrespective of who issued that card, reducing card issuing costs<sup>40</sup>.

### Barriers and relative disbenefits

- Limited to pre-purchase and pay as you go based on an e-purse topped up before travel<sup>41</sup>;
- ITSO is complex, which can lead to substantial capital and operating costs. Implementing and operating an ITSO scheme can be both time consuming and expensive due to technical complexity and the number of suppliers involved in any one scheme. Consequently, there is a risk of obsolescence as scheme operators start to move away from smartcard-based schemes towards cEMV and ABT.

### Value in an integrated ticketing scheme

- Medium – High: because it is interoperable and there is already a large installed base.

### Indicative investment ROM costs

Item	ROM Cost
Business case	£190,000.00
Settlement system	£90,000.00
Portal	£200,000.00
HOPS upgrade	£10,000.00
Cards	£100,000.00
Bus	£330,000.00
Rail	£30,000.00

<sup>40</sup> This is not quite true for the rail industry, where RSP rules require that only TOC issued cards are used. There is a technical reason for this, and theoretically provided all issued cards abide by the RSP card formatting, then the TOC only rule could be relaxed.

<sup>41</sup> Use of ITSO with ABT is covered in a subsequent section.

Project management, Technical consultancy & testing	£90,000.00
Marketing	£40,000.00
TOTAL	£1,080,000.00

Table 11 – Up-Front ROM Costs for an ITSO Card-Based Scheme

### Indicative operational ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£40,000
Settlement system	£90,000
Portal	£50,000
Replacement cards	£8,000
Support person	£140,000
Total	£328,000

Table 12 – Operational ROM Costs for an ITSO Card-Based Scheme

### Potential delivery timescales

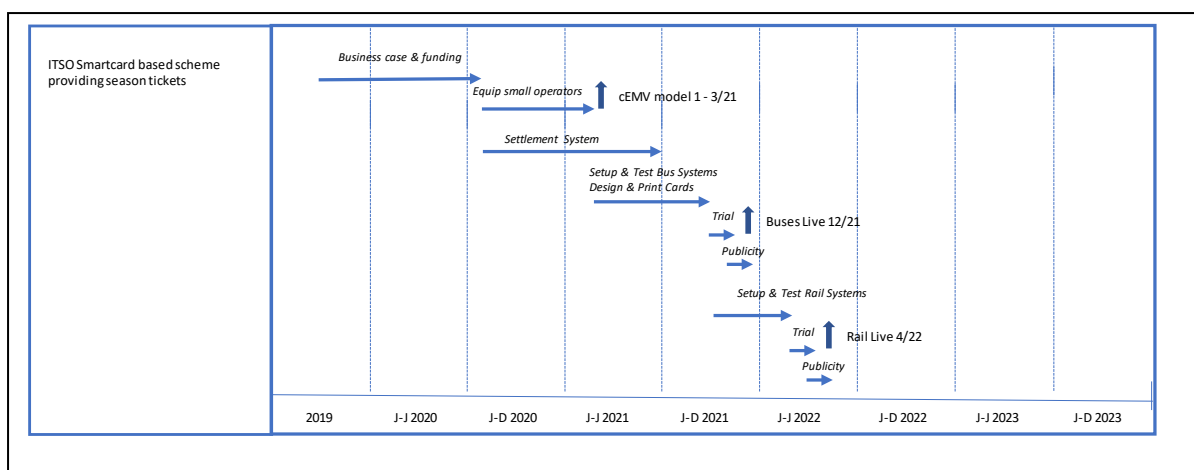


Figure 4 – Potential Delivery Timescales for an ITSO Card-Based Scheme

### 5.3 Schemes based on Mobile Phone apps.

All mobile phone ticketing apps support, to some degree, journey planning, ticket selection and purchase, and storage / validation of purchased tickets. There are three types of mobile phone ticketing app in use in the UK:

- First generation mobile phone app:
  - Tickets are validated visually, or possibly using a supplier proprietary barcode;
  - A number of suppliers provide these off the shelf with cosmetic customisation, e.g. company name and logo;
- Rail standard mobile phone app:
  - Tickets are validated using a barcode, formatted according to an RSP specification;
  - Currently being rolled out in the rail industry;
- “ITSO on mobile” phone app:
  - Currently being trialled:
    - ITSO’s own solution is being trialled on the West Midlands Metro;
    - Rambus’ solution is being trialled on the Glasgow subway;
  - Validation using the NFC interface and standard ITSO readers;
  - Currently limited to recent Android phones, but this is thought likely to change in the short to medium term. Both current suppliers have indicated that they are in discussions with other providers. ITSO advised that “ITSO's mobile fulfilment architecture lends itself to adaptation to working with any digital wallet provider. Our ambitions extend beyond Google to working with the other wallet providers”.

In the author’s view, mobile phone apps do not currently provide the sole basis for integrated ticketing. However, they do have major benefits in ticketing, and will be valuable as one aspect of a scheme. They can be used either to hold smart tickets, ITSO on Mobile for example, or as a token in an ABT scheme.

#### Opportunities and relative benefits

- Meets aspirational need of those who want to use their mobile phone for everything;
- Passengers can plan a journey, select and purchase a ticket, and validate that ticket using one device. The same app can be used to receive real time travel updates;
- The costs of issuing a smartcard are avoided;
- Full range of tickets except pay as you go<sup>42</sup>;
- The rail standard barcode provides for interoperability provided the same standard is adopted by bus operators for their apps;

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<sup>42</sup> Use of a mobile phone app as an ABT token is covered in section 5.4, in which circumstances pay as you go is possible.



- ITSO on Mobile apps can communicate with standard ITSO readers contactlessly, potentially more secure than visual and barcode-based validation;
- ITSO on mobile also integrates well with both ITSO card-based schemes and ABT schemes using ITSO as a token, and is therefore a steppingstone to those schemes, rather than a dead end.

#### Barriers and relative disbenefits

- First generation apps do not offer interoperable automatic validation unless upgraded to support the rail barcode standard or ITSO on Mobile;
- The multiplicity of phone types and operating system variants makes ensuring that apps will work with all phones difficult;
- ITSO on mobile currently suffers from a lack of iPhone support, however the signs are that Apple will open up support for NFC in the medium term;
- Not all customers can or will use a smartphone for ticketing (although this will change over time), therefore an alternative must be provided increasing scheme costs, at least in the medium term;
- Performance relies on availability of an internet connection;
- Validation speed can be slow, relying on the user opening the app prior to validation. Barcode based validation can be particularly slow;
- The customer must maintain a working phone, i.e. the battery must not become flat, during the course of the journey.

#### Value in an integrated ticketing scheme

- First generation – Low;
- Rail Barcode standard – Medium if adopted by bus operators, otherwise low, but note that this is not acceptable to TfL;
- ITSO on mobile - High: provided that iPhone support materialises.

#### Indicative investment ROM costs

Item	ROM Cost
Business case	£190,000.00
Mobile App	£90,000.00
Bus Operators	£420,000.00
Rail operators	£50,000.00
Branding & design	£80,000.00
Settlement system	£130,000.00
Merchant Acquirer	£20,000.00
Project management, Technical consultancy & testing	£90,000.00
Marketing	£40,000.00
TOTAL	£1,110,000.00

*Table 13 – Up-Front ROM Costs for a Mobile Phone application only*

#### Indicative operational ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
Settlement system	£90,000
Annual charge for app	£400,000
Support person	£70,000
<b>Total</b>	<b>£595,000</b>

Table 14 – Operational ROM Costs for a Mobile Phone application only

## Potential delivery timescales

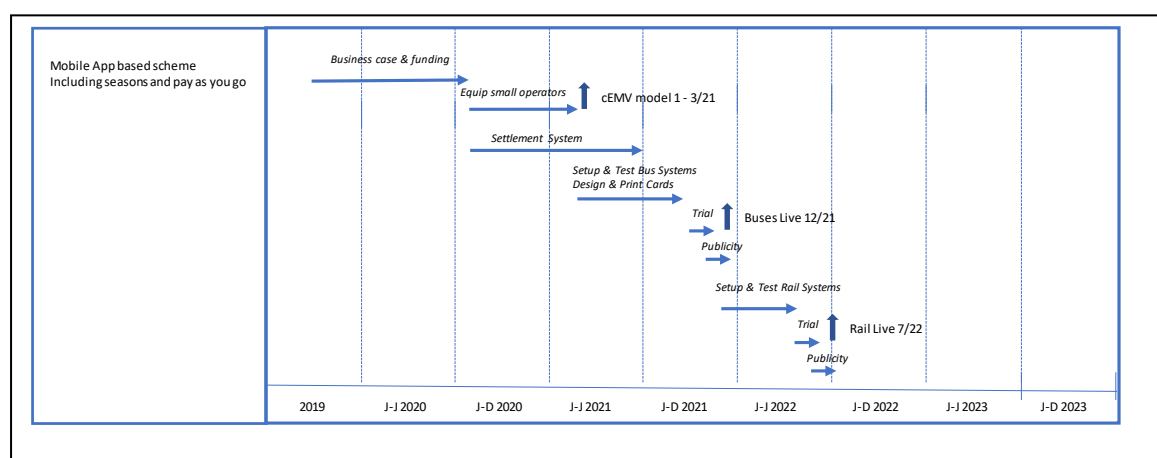


Figure 5 – Potential Delivery Timescales for a Mobile Application

## 5.4 Scheme combining both ITSO card based and Mobile Phone ticketing

In this scheme both ITSO card based and ITSO on mobile ticketing are provided.

### Opportunities and relative benefits

- Widely available and proven from a number of suppliers;
- The full range of ticket types is supported;
- Backed by the UK standard for interoperability (ITSO);
- Already installed at larger bus operators and currently being rolled out at rail operators;
- ITSO cards are multi-application, meaning that several operators products could be placed on a single card, irrespective of who issued that card, reducing card issuing costs<sup>43</sup>;
- Mobile apps:
  - o Meet the aspirational need of those who want to use their mobile phone for everything, whilst those who do not want to use a phone are also satisfied;
  - o Passengers can plan a journey, select and purchase a ticket, and validate that ticket using one device. The same app can be used to receive real time travel updates;
  - o The costs of issuing a smartcard are avoided for mobile phone users;

### Barriers and relative disbenefits

- Limited to pre-purchase and pay as you go based on an e-purse topped up before travel<sup>44</sup>;
- ITSO is complex, which can lead to substantial capital and operating costs. Implementing and operating an ITSO scheme can be both time consuming and expensive due to technical complexity and the number of suppliers involved in any one scheme. Consequently, there is a risk of obsolescence as scheme operators start to move away from smartcard-based schemes towards cEMV and ABT:
- Mobile phone apps:
  - o ITSO on mobile currently suffers from a lack of iPhone support, however the signs are that Apple will open up support for NFC in the medium term;

### Value in an integrated ticketing scheme

- Medium – High: because it is interoperable and there is already a large installed base.

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<sup>43</sup> This is not quite true for the rail industry, where RSP rules require that only TOC issued cards are used. There is a technical reason for this, and theoretically provided all issued cards abide by the RSP card formatting, then the TOC only rule could be relaxed.

<sup>44</sup> Use of ITSO with ABT is covered in a subsequent section.

## Indicative investment ROM costs

Item	ROM Cost
Business case	£190,000.00
HOPS upgrade	£10,000.00
Cards	£140,000.00
Bus	£320,000.00
Rail	£28,000.00
ITSO on Mobile	£90,000.00
Settlement system	£130,000.00
Portal	£200,000.00
Project management, Technical consultancy & testing	£130,000.00
Marketing	£40,000.00
<b>TOTAL</b>	<b>£1,278,000.00</b>

Table 15 – Up-Front ROM Costs for an ITSO Card-Based Scheme including a Mobile Application

## Indicative operational ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
Settlement system	£90,000
Portal	£50,000
Replacement cards	£23,000
Support person	£140,000
Annual charge for app	£400,000
<b>Total</b>	<b>£738,000</b>

Table 16 – Operational ROM Costs for an ITSO Card-Based Scheme including a Mobile Application

## Potential delivery timescales

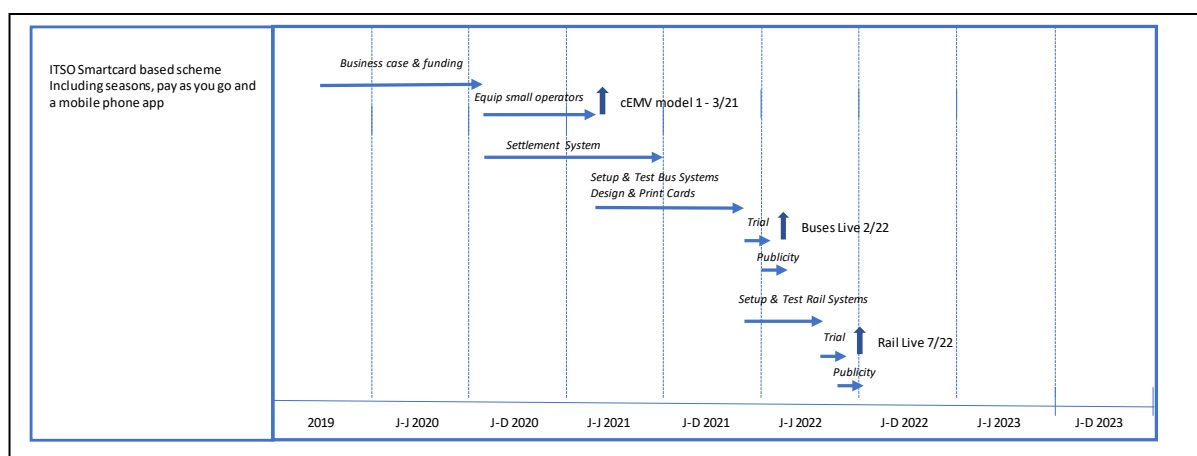


Figure 6 – Potential Delivery Timescales for an ITSO Card-Based Scheme including a Mobile Application

## 5.5 Account Based Ticketing (ABT) schemes

There are a number of forms of ABT scheme, which because of their different characteristics are analysed separately. Essentially, tickets are held in a database forming part of the ABT back-end, and an electronic token used to link the passenger to the appropriate record (ticket) in the database, so that tickets can be validated on-line.

In all the cases discussed it is assumed that an off-the-shelf ABT back office will be used, avoiding development costs.

#### 5.5.1 Pre-pay with a bank card, which is then used as a token to travel.

This form of ABT was designed for long distance ad hoc travel, such as rail journeys. It utilises bank cards as the method of payment and also as an identity token for travel, i.e. the bank card is presented at gates and other inspection points to validate the ticket. Known as cEMV Model 3, this approach has not been implemented. Note that a mobile phone wallet emulating cEMV can similarly be used as the token.

##### **Opportunities and relative benefits**

- None identified for Greater Cambridge integrated ticketing.

##### **Barriers and relative disbenefits**

- Not currently implemented;
- Not suitable for (and not intended for) short distance integrated ticketing.

##### **Value in an integrated ticketing scheme**

- Very low.

##### **Indicative costs**

Costs for this option have not been analysed.

##### **Potential delivery timescales**

Timescales for this option have not been analysed.

#### 5.5.2 Single token ABT, with a cEMV card used as the token.

This is the pay as you go 'contactless' system implemented by TfL and defined as cEMV model 2. Typically, best fare calculation is provided, ensuring that the aggregate fare charged for multiple journeys does not exceed the fare charged for a season ticket. Bank issued cEMV cards can be used as the payment mechanism, and this is the approach adopted by TfL. Note that a mobile phone wallet emulating cEMV can also be used as the token.

Some customers will not or cannot use a bank card, and an alternative must be provided incurring additional cost. The alternative could be a conventional smartcard-based solution, or a solution based on private label cEMV cards.

In the absence of single ABT scheme covering for buses the whole area where services originating in Greater Cambridge terminate outside the area and for rail a UK national scheme, then there are restrictions on which journeys passengers can make. They cannot use their cEMV card for journeys

which terminate outside the ABT scheme area, and to avoid customer service issues customers must be educated in how they can use the scheme.

#### **Opportunities and relative benefits**

- Utilises existing readers where cEMV model 1 already implemented, reduces implementation cost;
- Customer provides their own token, reducing costs;
- Token is also the payment means, reducing payment default risk and simplifying the system;

#### **Barriers and relative disbenefits**

- Some customers cannot or will not use a bank card, so an alternative must be provided incurring cost.

#### **Value in an integrated ticketing scheme**

- High

#### **Indicative investment ROM costs**

<b>Item</b>	<b>ROM Cost</b>
Business case	£190,000.00
ABT back office	£160,000.00
Bus	£300,000.00
Rail	£80,000.00
Settlement system	£120,000.00
cEMV set up	£50,000.00
Portal	£200,000.00
Project management, Technical consultancy & testing	£100,000.00
Marketing	£40,000.00
<b>TOTAL</b>	<b>£1,240,000.00</b>

*Table 17 – Up-Front ROM Costs for an ABT Scheme using cEMV Cards as Tokens*

### Indicative operational ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
Settlement system	£90,000
Portal	£50,000
cEMV costs	£40,000
Support person	£70,000
ABT Back office	£100,000
Total	£390,000

Table 18 – Operational ROM Costs for an ABT Scheme using cEMV Cards as Tokens

### Potential delivery timescales

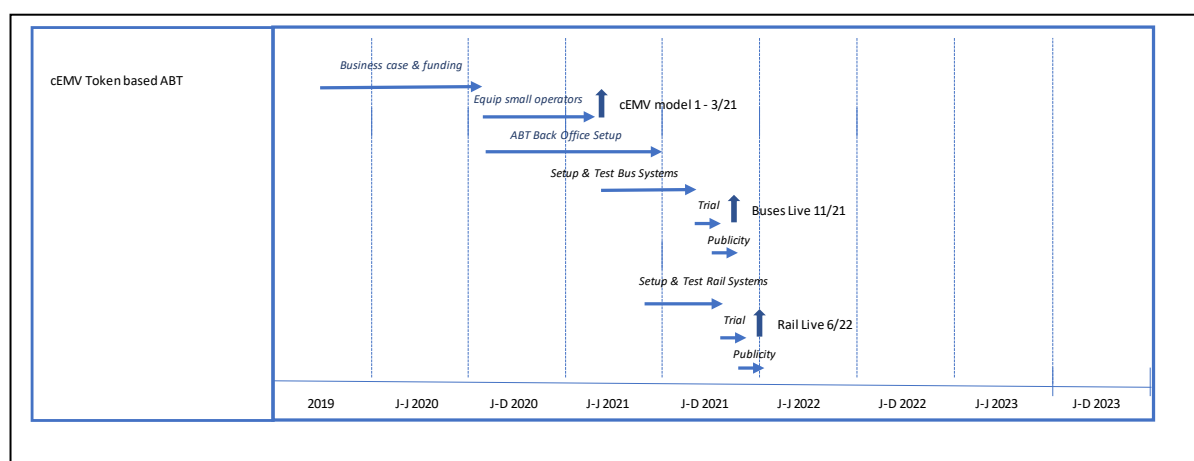


Figure 7 – Potential Delivery Timescales for an ABT Scheme using cEMV Cards as Tokens

#### 5.5.3 Single token ABT, with an ITSO card used as the token.

This type of ABT system utilises ITSO cards as a token, and the existing ITSO infrastructure, but has not yet been implemented. Pre, post pay and capped pay as you go modes are supported, as are all ticket types. Note that a mobile phone emulating an ITSO card can be used as the token, and is included in the cost estimates.

#### Opportunities and relative benefits

- Utilises existing readers, reduces implementation cost;
- Support for pre, post pay and capped pay as you go modes, and any ticket type.

### Barriers and relative disbenefits

- Card issuing costs;
- ITSO complexity cost persists, but lower than with a traditional card based ITSO scheme because there is only one simple product in the card.

### Value in an integrated ticketing scheme

- High.

### Indicative investment ROM costs

Item	ROM Cost
Business case	£190,000.00
ABT back office	£140,000.00
Bus	£470,000.00
Rail	£50,000.00
Cards	£140,000.00
Settlement system	£130,000.00
Portal	£200,000.00
ITSO on mobile app	£90,000.00
Project management, Technical consultancy & testing	£140,000.00
Marketing	£40,000.00
TOTAL	£1,590,000.00

Table 19 – Up-Front ROM Costs for an ABT Scheme using ITSO Cards as a Token

### Indicative operational ROM annual costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
Settlement system	£90,000
Portal	£50,000
Replacement cards	£23,000
Support person	£70,000
Annual charge for app	£400,000
ABT back office	£100,000
Total	£768,000

Table 20 – Operational ROM Costs for an ABT Scheme using ITSO Cards as a Token



## Potential delivery timescales

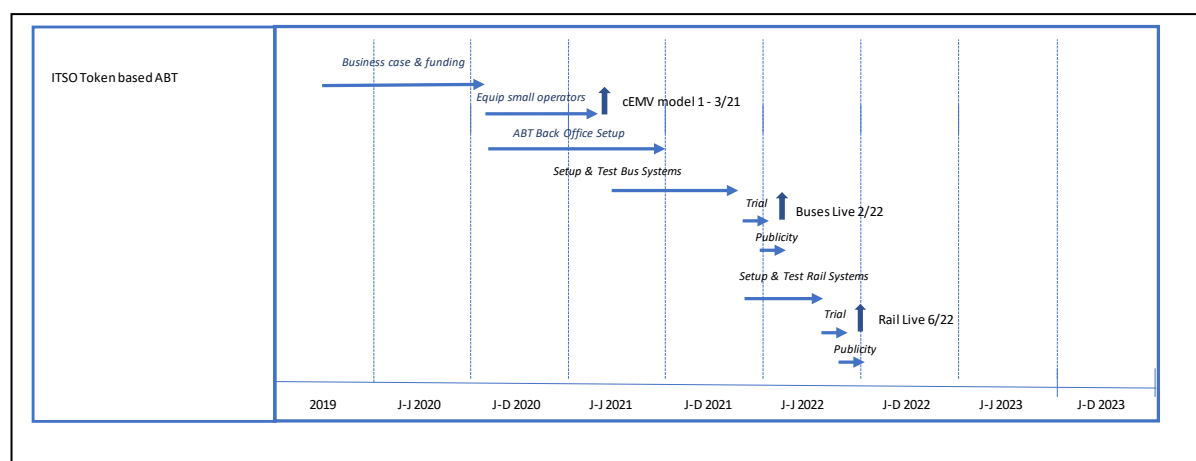


Figure 8 – Potential Delivery Timescales for an ABT Scheme using ITSO Cards as Tokens

### 5.5.4 Single token ABT, other token type.

Whilst not currently implemented, ABT using a token type other than ITSO or cEMV is possible. However existing readers only support ITSO and possibly cEMV, and would have to be upgraded or replaced to accommodate the new token type unless the token emulated cEMV, perhaps being a contactless smartcard loyalty token or private label prepaid card.

#### Opportunities and relative benefits

- Support for pre, post pay and capped pay as you go modes, and any ticket type.

#### Barriers and relative disbenefits

- High implementation capital cost in providing a new form of validation terminal;
- Technology has not been implemented in the UK.

#### Value in an integrated ticketing scheme

- High.

#### Indicative investment costs

- Costs have not been analysed.

#### Potential delivery timescales

- Timescales have not been analysed.

### 5.5.5 Multi-token ABT schemes

This is getting close to the ideal ticketing system based on proven “state of the art” technology but has not yet been implemented. Because multiple token types, smartcards, cEMV cards and mobile phones, can all be used, it is acceptable to all customers, and the requirement to provide alternatives for those who cannot or will not use mobile phones or bank cards for transport is avoided. ITSO smartcards are proposed because of the existing reader base avoiding replacing or upgrading readers.

#### Opportunities and relative benefits

- Utilises existing readers (ITSO and cEMV), reducing implementation cost;
- Support for pre, post pay and capped pay as you go modes, and any ticket type;
- Acceptable to all customers;
- Cards are only provided for ITSO customers, other customers provide their own token, reducing cost;

#### Barriers and relative disbenefits

- Multiple token types increase scheme complexity, and therefore cost;
- Multi-token ABT back office may require development investment;
- ITSO complexity cost persists, but lower than with a traditional card based ITSO scheme because there is only one simple product in the card;

#### Value in an integrated ticketing scheme

- Very high, because it can replace all existing non-concessionary<sup>45</sup> ticketing.

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<sup>45</sup> Concessions could also be replaced, but this requires a national ABT scheme.

## Indicative investment ROM costs

Item	ROM Cost
Business case	£190,000.00
ABT back office	£160,000.00
Bus Operators	£330,000.00
Rail operators	£100,000.00
Branding & Cards	£60,000.00
Settlement system	£130,000.00
cEMV set up	£50,000.00
Customer portal	£200,000.00
Project management, Technical consultancy & testing	£190,000.00
Marketing	£40,000.00
TOTAL	£1,500,000.00

Table 21 –Up-Front ROM Costs for and ABT Scheme using cEMV and ITSO Cards as Tokens

## Indicative operational ROM costs

Item	ROM Cost
Small operators, ITSO costs	£35,000
Settlement system	£90,000
Portal	£50,000
ABT back office	£100,000
cEMV costs	£40,000
Replacement cards	£7,000
Support person	£70,000
Total	£392,000

Table 22 – Operational ROM Costs for and ABT Scheme using cEMV and ITSO Cards as Tokens

## Potential delivery timescales

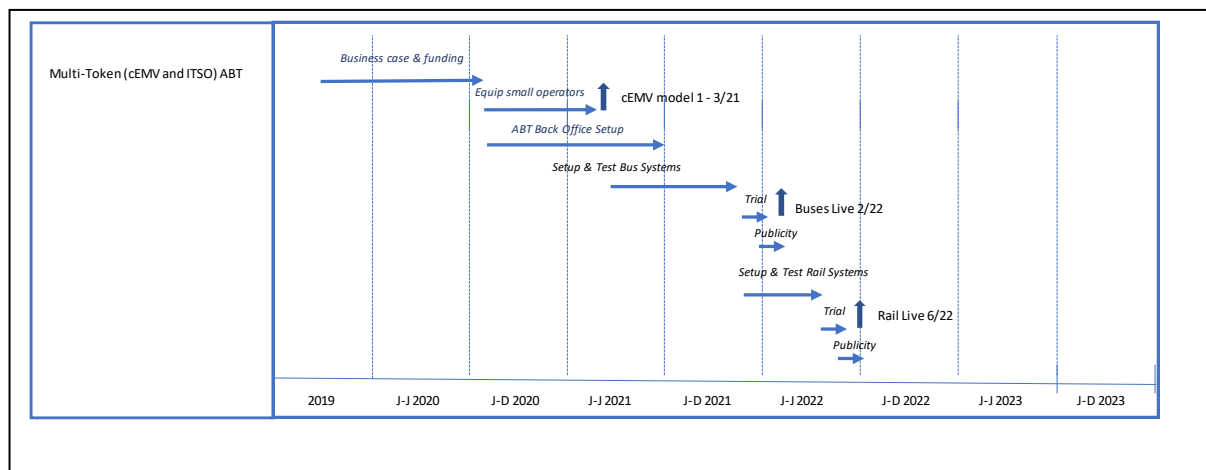


Figure 9 – Potential Delivery Timescales for an ABT Scheme using cEMV and ITSO Cards as Tokens

## 5.6 ITSO Card and Mobile Based, Migrating to ABT at a Later Stage

This option sees the Council starting with a card and mobile based scheme, and then migrating to ABT as the technology matures.

### Opportunities and relative benefits

- A safer approach because ITSO card-based technology is mature, reducing technical risk. ABT can then be introduced when that technology is mature;
- All the benefits of both card-based and ABT schemes apply, although realisation of the ABT scheme benefits is delayed.

### Barriers and relative disbenefits

- All the disadvantages of an ITSO card-based scheme as previously discussed apply until the ABT scheme is introduced;
- Additional cost – essentially two different schemes are implemented in succession, and then the first scheme is abandoned.

### Value in an integrated ticketing scheme

- Very high, because it can replace all existing non-concessionary<sup>46</sup> ticketing.

### Indicative investment costs (for those options which do not fail on other criteria)

- Costs can be assumed to be one and a half to two times the cost of providing either an ITSO card-based scheme or the ABT scheme.

<sup>46</sup> Concessions could also be replaced, but this requires a national ABT scheme.

**Potential delivery timescales**

- Timescales for delivery of the ITSO card-based scheme will be similar to those estimated for the ITSO based scheme previously described in section 0. Development of the ABT scheme could progress once the Council determine that the technology is sufficiently advanced and available, and funding is available. At best ABT would be delivered in twice the time estimated for adopting the technology from the outset, as previously described in section 0.

## 5.7 Comparison of Scheme Implementation Timescales

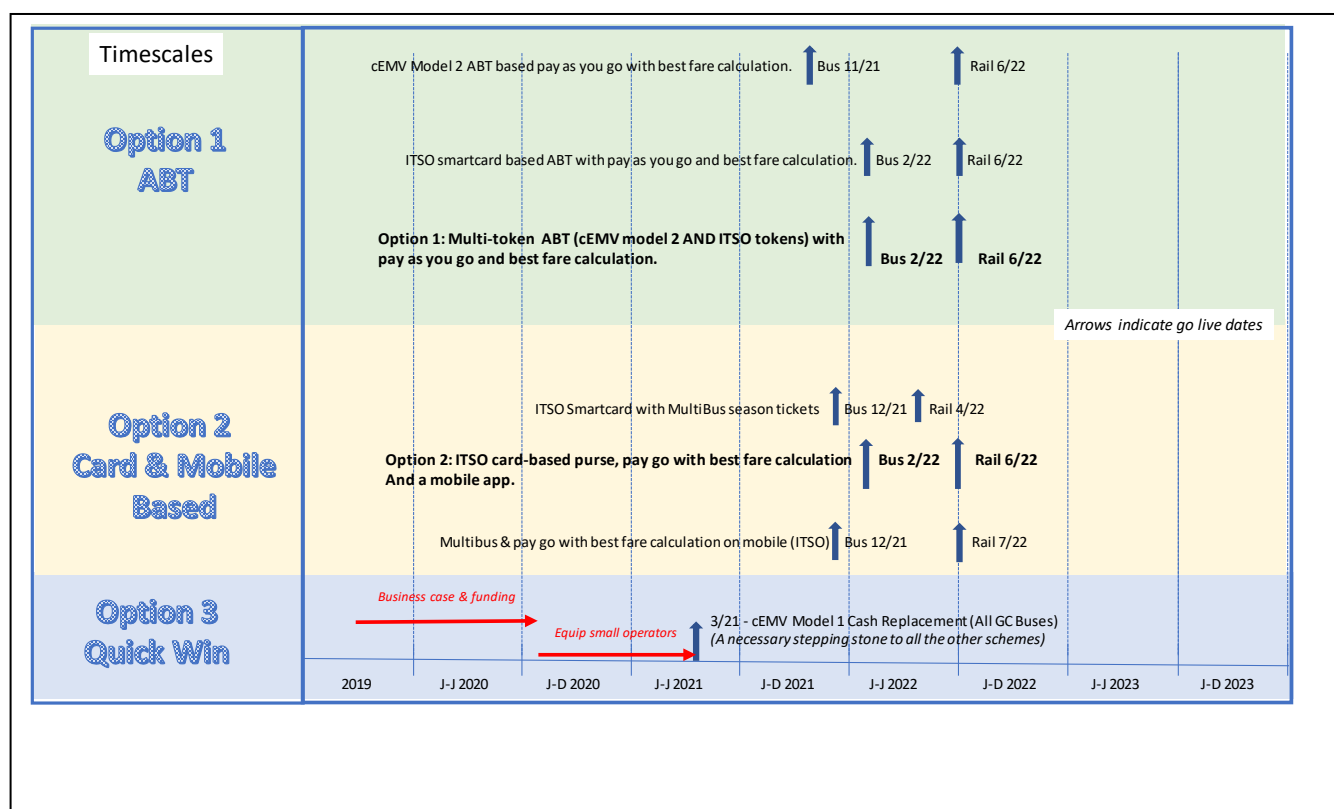


Figure 10 – Comparison of Scheme Implementation Timescales

The above diagram shows three roadmap and timescale options; the first leads to the multi-token ABT scheme described in section 5.5, while option 2 leads to the extended ITSO scheme described in section 0 and encompassing multi-operator PAYG with capping. Section 7 of this report looks at the merits or otherwise for adopting either option 1 or option 2.

Option 3 cEMV model 1 can be implemented on its own or in parallel with either option 1 or option 2 as an early deliverable or quick win. On its own cEMV contributes to later implementations of option 1 ABT where cEMV is used as a token, and to the ITSO options if the upgrade includes ITSO functionality.

It is also possible to consider implementing both option 1 and option 2, possibly due to external influences such as aiming for option 2 but needing to support an external system as might be the case with Stagecoach, or more simply because one is strong on desire for option 1 but not trusting enough to commit 100% to it. The option 2 card and mobile based solution would be delivered first followed by the option 1 ABT solution in due course. There will of course be a time penalty as well as a major cost penalty in delivering the ABT system.

## 5.8 Comparison of Scheme Costs

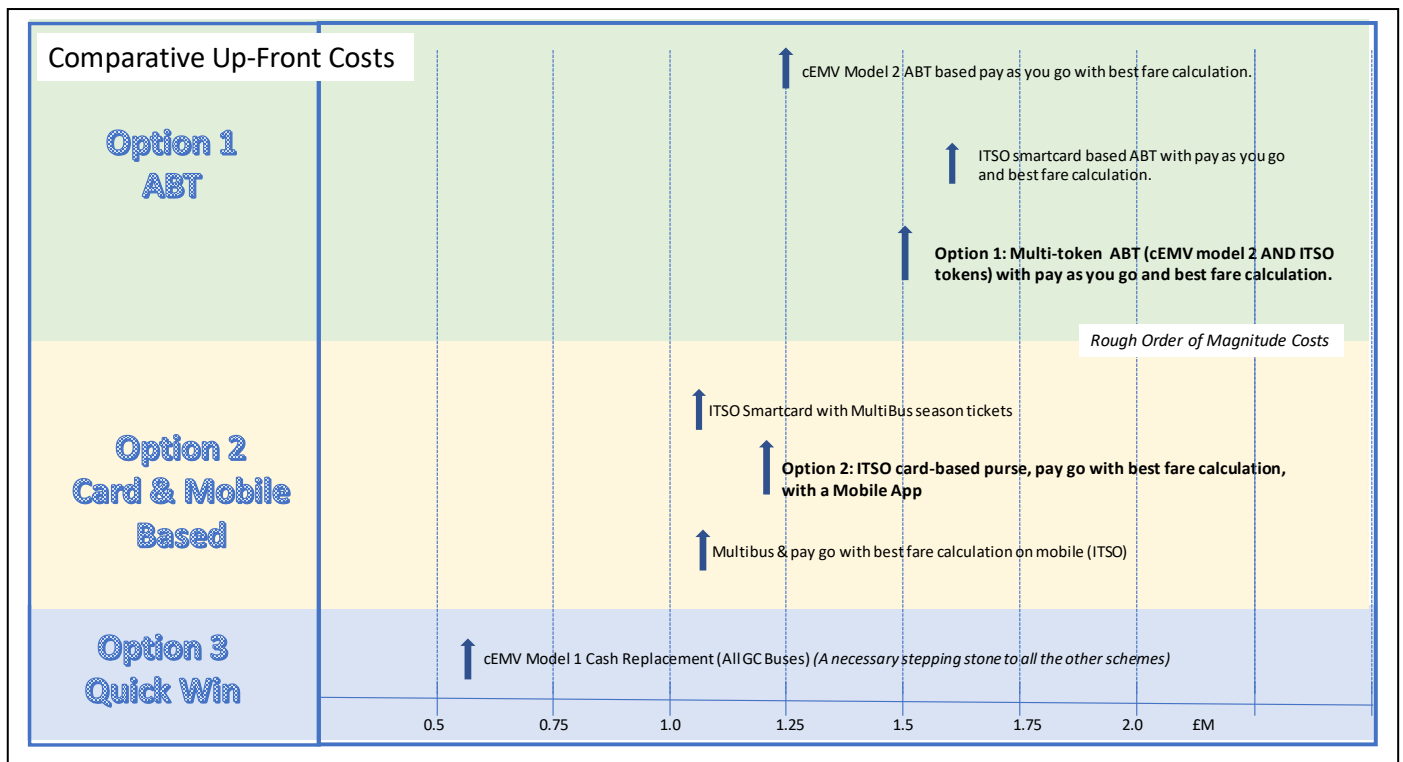


Figure 11 – Comparison of Scheme Up-Front Costs

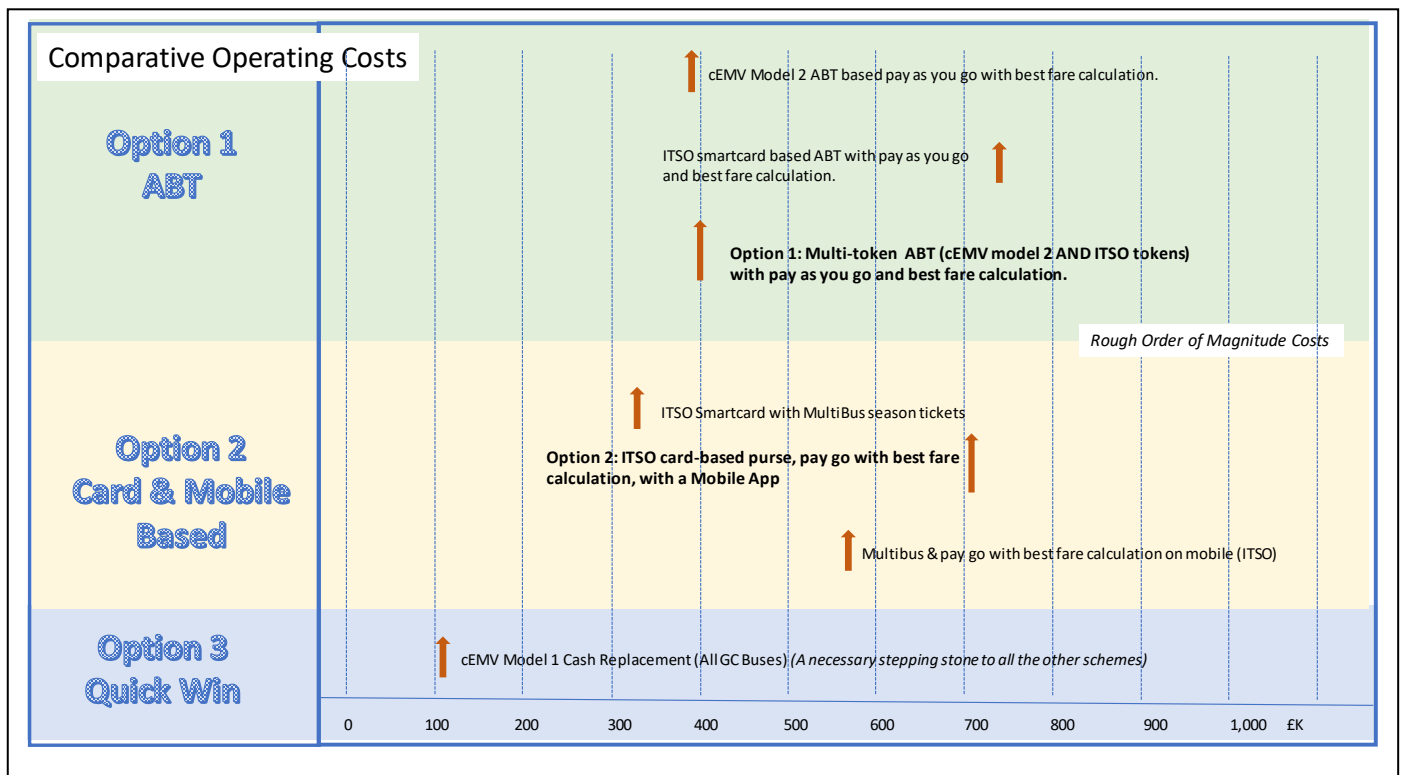


Figure 12 – Comparison of Scheme Operational Costs

## 6. The longer term

### 6.1 Rationale for consideration

Although technologies and services in the longer term cannot be predicted with any accuracy and neither can we know too much about the business direction of The Greater Cambridge Partnership and its partners, looking in the longer term allows us to develop a roadmap from where we are to where we want to be knowing that the further into the distance we look along the roadmap the less accurate it will be. However, by updating the roadmap year-on-year, one can attain consistency in short to medium term accuracy.

In particular, we consider what has to be done today to prepare for future activities without requiring expensive re-builds and thereby ensuring a future-proofed way forward.

### 6.2 Data aggregation, sharing and analytics

We have considered a technology roadmap to integration in the short to medium term in section 4.5, here we look beyond that. In an online environment interfacing with the user through a portable communicator such as a mobile phone, integration clearly implies joining up services such as enquiry, real time information, booking, reservation, payment and transport system access. In addition, it will include multimodal travel plans allowing single ticketing, single booking across bus, rail, metro, tram, and optionally toll, parking, cycle hire offered by a variety of transport operators.

As stated above we have considered this level of integration in earlier sections of this report however, what does this level of integration imply under the skin? In order to provide the necessary information and to organise an integrated service, the system must be able to access a variety of service databases and acquire information relevant to the customer. If all the underlying data is correlated and assembled into a single dataset organised by customer or service or operator, data analysis will be able to analyse the data to provide new information that may be used to improve services.

But will competing operators want their data to be integrated with their competitors? Will the data privacy laws be broken? And regardless, the customer's data belongs to the customer and it is therefore up to the customer to approve both access to and usage of their data. How will the customer provide permission and if achievable, would they have to do it once or many times? What happens if only some but not all customers allow access to their data?

These issues are well known and have been addressed many times from different standpoints and as yet no single answer has been arrived at. It is a context and stakeholder specific problem whose complexity increases as the number of stakeholders goes up, and it is very much a customer issue where large numbers of customers are involved for example, in a public transport environment.

While many of these issues may be deferred until the longer term becomes the medium term, by considering the problem early on, its **commercial, legal and political aspects** may be addressed and resolved early on, before committed expenditure on technology is required.



### 6.3 Mobility as a Service (MaaS)

The above discussion on integration leads one to a consideration of who manages the integration of services. It could be the major stakeholder, or the AFC system operator, or an appointee of a panel of stakeholders. However, consideration is increasingly also being given to management by an independent third party who manages the shared data, customer and stakeholder services. This entity may start with the integration of just a few services and slowly build up to many services, noting that the more services in the integrated pool the more benefit accrues to both customers and stakeholders.

This concept is known as Mobility as a Service (MaaS) and consideration is being given by many organisations as to how this may be achieved. From a practical perspective the MaaS provider would have its integrated environment sitting as a single entity over and above, and interfacing with each of the individual services to be included in the integrated whole. While from a technical point of view this is an obvious way to approach the issue, it implies an additional layer of software and operations over and above that already provided by the individual services. The effect of this will be to add cost into the system without equivalent savings. Therefore, a business case cannot be made which is the case with Whim, one of the leading MaaS pioneers in the market today.

A possible solution would be for one of the base systems to take on the role of the MaaS service provider and for it to interface directly with other services, thereby keeping the implementation to a single level and not introducing new stakeholders. One complexity with this approach is that the MaaS service provider is very likely to be one of the transport providers involved in the scheme. This leads to concerns over data sharing and privacy, with the MaaS service provider achieving commercial advantage over other transport providers.

An alternative approach which gets around the business case issues with third party MaaS providers is for a not-for-profit organisation to provide the service. This organisation could conceivably be a local authority wholly owned company, or alternatively a “club” style organisation similar in concept to Rail Settlement Plan Ltd or ITSO Ltd.

However, if either of these approaches is to work, and knowing that it will not happen all at once, standard interfaces must be defined to operate between the MaaS provider and the individual services to be incorporated in the MaaS provision. It is therefore important that an interface standards group be set up at an early stage to specify the necessary **interface standards** so that as new software is introduced to provide new services or upgrade existing servers, these services can be built to adhere to the standards ensuring that downstream into the longer term, integration may be facilitated without significant software rewriting.

### 6.4 Smart cities

The smart city concept claims to use technology to provide integrated services across all sectors applying to the city in combination with changes brought about by non-technological means, for example, rerouting cycleways away from roads carrying motorised traffic. Technology may be used to support these changes, for example, changing traffic lights to green to allow emergency services to travel to where they are needed in the optimum time.

The smart city may be seen as one where MaaS applies to the transport network and similar integrations apply to other sector services such as housing, healthcare and social services; all

integrated to provide a single portal into a city's services. It is probable that the smart city concept will be based around cloud services with a single defined interface for customers, stakeholders and service providers alike.

It is noted that the public transport ticketing system is already a digitised application providing services to a large proportion of the city's citizens and for this reason it is likely to be the driver towards a smart city, especially if MaaS is provided along the way. With this in mind, it would be a wise move for the above mentioned MaaS standards group to include specification of more general **smart city interface standards** that would suit smart city applications as and when required.

## 6.5 Future proofing

The value in taking the longer-term view is clear to see in that schemes may move forward confidently knowing that they will be prepared for downstream interfacing to MaaS environments and smart cities as and when the time comes. By understanding the requirements of the future, one can be more certain about the roadmap from where one is today to where one wishes to be.

It is apparent that the future starts now. At the earliest time it is necessary to make sure that the appropriate standards are specified and that a forward-looking governance group is created to consider the commercial legal and political issues involved.

This report considers multiple approaches to the way forward in the short to medium term and ends with a single long-term solution. The ability to end up in the same common future supports and validates the multipath approach taken in the body of this report.

## 6.6 Roadmap

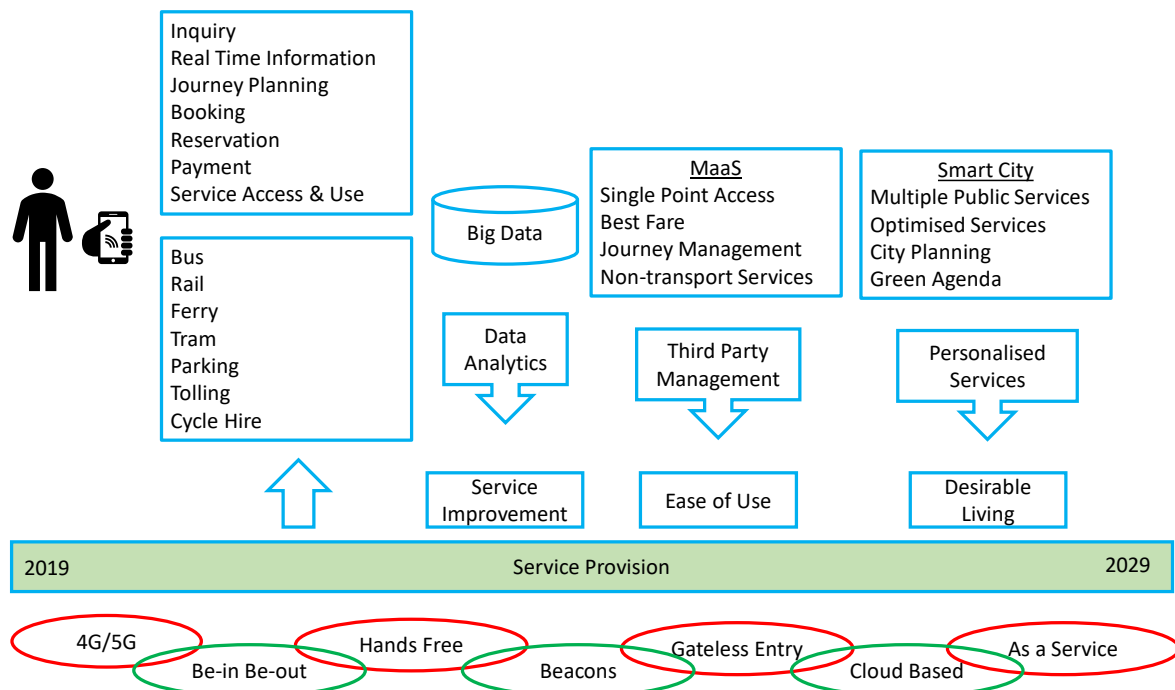


Figure 13 – Roadmap - the Longer Term

The above diagram highlights the development of services over the coming 10 years which depend upon the user having an intelligent communicator (e.g. mobile phone) to access the services. The

specific timing of the provision of services will depend on the wishes of the scheme stakeholders, the provision of the necessary hardware and software, and the readiness of external services (e.g. social services special needs transport requirement scheduling).

The lower section of the diagram shows the required enabling facilities in red based upon technology provision, in green. The diagram is not to scale and the lower section should not be seen as mapping timewise to the upper section.

As a result of disruptive action by protesters, coupled with the serious comments of Sir David Attenborough, there is a sudden emphasis on man-made climate change and how we must act now to reverse it. Emphasis has been placed on fossil-fuelled surface transport, aviation, soil erosion and the production of environmentally harmful gases; while expectation has been derogated to all levels, including individual members of the public, representative groups, local authorities, central government and the UN. It would be wrong for the Council to make any specific claims at this time with respect to playing its part in totality of a UK contribution towards combatting climate change; however, by moving to an ABT solution, it will have created the basis for addressing climate change directly or via beneficial provision of services including big data collection and analytics, MaaS, smart cities, demand responsive transport, and encouraging more people to move from private to public transport.

## 7. Recommendations

### 7.1 Approach taken

Clearly everyone cannot be fully satisfied in a short time and with no impact on existing travel provision. The foregoing sections of this report highlight the various technical and service facilities both available and becoming available at some point in time according to a roadmap to realisation over the coming years. This section takes a practical look at what combinations of technologies and related services fit together and can be delivered over time causing the minimum disruption to ongoing passenger services.

### 7.2 Selection choices

Section 4 details the technologies and products both existing and future for consideration in this study. Section 5 then analyses the benefits cost and timescale of the various options as input to this section which starts by summarising the options as a lead-in to making recommendation for the way forward.

Our selection of a recommended scheme is based on the overall benefit to travellers within the Greater Cambridge area and to the various stakeholders. Our choices are based on the following criteria:

- Time to implementation;
  - o Shorter timescales mean that the benefits are realised earlier, and some costs, project management for example, are reduced;
- Implementation costs;
  - o Improved value for money improves the business case and makes securing funding easier;
- Opportunities & relative benefits;
- Barriers and relative disbenefits;
- Risks;
- Future proof technology;
  - o Implementing a technology which is likely to remain current for many years reduces the risk of early obsolescence and replacement costs.

#### 7.2.1 Architectures

##### Card centric system

This is today's standard in general use meeting the needs of the majority of the population in the UK. It is clearly an option being well proven, understood and available from many sources. However, there is a move in the industry towards newer, more cost effective systems and it could be argued that to employ a card centric architecture would not be a good approach to take today as it would have to be replaced in a few years by a new system meaning twice the upheaval and twice the cost.

## Account based system

The new account-based system is less mature and brings with it some new risk. It is inherently more flexible than a card centric system but does rely on near real-time communications. In terms of moving from card centric to account based working, it is perfectly possible to have both systems running side-by-side, each serving different facilities. Examples of this dual operation may be found in London and Vancouver which, among other things, shows how transition from one to the other may be achieved in a step-by-step manner.

### 7.2.2 Standards

#### ITSO

The ITSO specification is the standard supported by the DfT for use across the UK including both normal and concessionary fares. It is now receiving strong government support and its deployment is expected to grow quickly.

#### Oyster

London adopted the Oyster standard which has proven to be highly successful. It was not supported by the DfT because it was based on a proprietary system although TfL has now acquired all the IP. Cubic Transportation Systems has acquired a license to sell the Oyster account based back office around the world.

#### Supplier's private design

Historically, most AFC systems are based on supplier's private designs. Although in general, most of these systems are well tried and tested, their big disadvantage is that they are not interoperable with other systems making it impossible to integrate with systems from other suppliers.

#### Contactless cEMV Bank Cards

Bank cards are produced to a standard created by EMV<sup>47</sup>, with the contactless variety becoming increasingly important as a method of payment for public transport.

### 7.2.3 Tokens

This report identifies the need to support multiple token types if all user demographics are to be properly catered for. The problem with supporting multiple token types is that different tokens have different capabilities. In section 4 **Error! Reference source not found.** we highlight where different tokens may or may not be used.

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<sup>47</sup> Originally Europay, Mastercard, Visa, the standard is currently defined and managed by the privately-owned corporation EMVCo LLC. The current members of EMVCo are [JCB International](#), [American Express](#), [Mastercard](#), [China UnionPay](#), [Discover Financial](#) and [Visa Inc.](#)

## 7.3 Recommendations

### 7.3.1 Quick Wins

Cambridgeshire are naturally keen to implement some form of integrated ticketing promptly, in order to obtain the benefits as soon as possible. Figure 10 in section 5 shows the roadmap and timeline for the two main approaches, working towards an ABT based solution or working towards a card-based solution, both achieving multi-operator ticketing including PAYG and best fare through capping.

There are a number of routes to a quick win, all of which have their advantages and disadvantages. They fall into two categories:

- As a stepping stone to the main target, ABT or card based as the case may be. There is a clear advantage in that any money spent is not wasted and there is a positive impact on the roadmap. However, the disadvantage is that it is not really very quick.
- As an independent provision, as discussed in section 5. The obvious disadvantages are the cost which will be in addition to the cost of implementing the main programme, and that its lifespan will be limited. There are a number of approaches to this type of quick win, the choice of which way to go being a combination of opportunity, price and the Council's wishes. The options under consideration are:
  - cEMV cash replacement using bank cards and mobile phone wallets for ticket purchase across the whole area. Whilst not strictly integrated ticketing it does have the advantage of being convenient for bank card carrying passengers and has become extremely popular. Benefits include:
    - Stagecoach and the rail stations are already equipped, whilst Whippet are seriously considering an upgrade to accommodate this method. Therefore, the only investment required for coverage across the Greater Cambridge area is upgrading bus equipment on the small bus operators' services;
    - The bus upgrade will be required anyway as an enabler for any full-scale integrated ticketing scheme;
    - All bus operators will validate ENCTS passes electronically, provided ITSO functionality is included in the upgrade, providing better data to the Council and allowing hot listing of lost and stolen passes.
  - Migrating the existing Multibus ticket to ITSO smartcards. This takes advantage of the investment in smart ticketing equipment at the small bus operators and Whippet, and the existing compatible equipment already in use by Stagecoach and the rail operators. However, there are drawbacks:
    - Current take up of Multibus tickets is very low, and it is not certain that migration to smartcards and extension to rail will improve this significantly;
    - Delivery is only likely to be a few months before the full ABT scheme can be delivered;
    - Investment in Multibus would probably delay delivery of the full main scheme by diverting effort from that project.
  - A third approach is an ITSO compatible mobile app. Based on Rambus's timescales this could be available as soon as seven months after upgrade of all buses to accept ITSO cards. This approach has all the advantages of mobile apps., but some disadvantages as well:

- Only high-end and recent Android phones are compatible, reducing the quantity of customers who can use it;
- Apple users cannot use the app until such time as Apple open up their systems for this type of use;
- The app can only be used by bank account holders who are comfortable to use their phone for ticketing;
- Additional cost will be incurred as the app is not required for the recommended multi-token ABT solution; and
- Users must maintain sufficient battery charge to keep their phone working for the duration of their journey.
- Finally, as the authors understand it AGA and Stagecoach are working on a joint proposal involving the sale by AGA of point to point rail tickets combined with a day pass valid on Stagecoach services in the Greater Cambridge area<sup>48</sup>
  - If this happens, the scheme is likely to be largely or wholly funded by the operators involved;
  - But does a scheme limited to two operators meet the Council's aspirations?
  - Will a scheme limited to two operators meet the requirements of the Competition and Markets Authority's Block Exemption for public transport ticketing, because it is not open to all operators?
  - It's not yet clear how many passengers would take advantage of the scheme, bearing in mind the very limited take-up of the existing MultiBus ticket;
  - Clearly, further investigation is required.

### 7.3.2 Full Scheme (ABT based)

For the "full scheme", we have a choice of a multi-token Account Based Ticketing (ABT) scheme (option 1 in section 5.7) or the equivalent card based alternative (option 2). We favour the multi-token ABT approach which delivers an all-embracing scheme design enabling the use of cEMV bank issued cards, ITSO cards, Mobile Phone applications and wallets, and private label cEMV cards as tokens, and satisfying the needs of all customer types. Key determining issues are:

- Implementation appears to be similar to that for card centric approaches and their concomitant support for PAYG (0) and mobile phones (5.4)
- Costs are greater for option 1 (£1.5M vs £1.2M), however operating cost reductions are likely based on reduced use of ITSO card-based technology.
- The technology is future proof in that other operators are turning away from card-based schemes and adopting ABT technology;
- Several companies have launched or are developing the required back-office systems;
- The scheme leads to multi-token support which enables the use of:
  - A bank card for preference, meaning that the costs of issuing a card are avoided for these users, with the card also acting as the method of payment;
  - A mobile phone wallet emulating a bank card can similarly be used as the token by those passengers who want to do this;
  - An ITSO card because bus & rail are already equipped with ITSO compliant systems, satisfying the needs of those users who cannot or will not use a bank card or a mobile phone;

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<sup>48</sup> Source: AGA telephone interview.

- A private label cEMV in the longer term to replace ITSO cards should a business case demonstrate value for money advantages.

### 7.3.3 Alternative Full Scheme (Card based)

A card-based environment could come close to matching the above ABT scheme in that it can offer almost the same services, but it is not future proof and would have to be replaced as new technologies and services appear. The medium to long term business case would therefore be less able to demonstrate good value for money.

The question of trust becomes important here in that card-based schemes are well proven while account-based schemes are in their infancy. If GCP are not comfortable that by the time they get there ABT will still not be mature, then they have two choices, develop along the card-based path or develop both in parallel. Although it will cost significantly more, this latter approach is the “safe bet”.

## 7.4 Specific Services

The major schemes described above can offer many services as described elsewhere in this study however, there is latitude in whether to provide different support options and the order in which they are implemented.

### 7.4.1 Payment by contactless bank card

Contactless bank card payment (5.1.2) is useful to customers who qualify for a bank account or credit card, and is as already noted an important stepping stone in developing the full system. However, many customers do not qualify for a card, and some customers will not use one for travel, and therefore an alternative must be provided for them increasing costs.

### 7.4.2 Supporting ITSO

A number of schemes have been implemented using ITSO card-based technology (0), for example the Travelmaster in South Yorkshire and Swift in the West Midlands. These have the advantage of using tried and tested technology, and of utilising the existing ITSO readers provided for the ENCTS scheme. However, all card-based schemes are complex to manage and maintain, and many scheme operators are looking towards Account based schemes as a way forward. For example, the West Midlands recently submitted a bid (albeit unsuccessful) for an ABT scheme to replace their card-based scheme. London have also moved much of the Oyster traffic into an ABT scheme.

### 7.4.3 Mobile phone functionality

As a ticketing device, mobile phones (5.3) are very attractive. Not only can they store tickets, but they can be used for journey planning, ticket purchase and real time journey updates. As such they eliminate some scheme operators’ costs, card issuing and retailing equipment costs for example. However, they do have drawbacks. Currently only high-end smart phones are suitable, particularly if the more secure NFC interface is used, and therefore not everybody has a ticketing capable phone. Additionally, some customers will not use their phone for ticketing because they are fearful of doing so, don’t qualify for a bank account card to use as the payment mechanism or actually find it less convenient. The phones battery must be kept charged for the duration of the journey, some operators have adopted a zero-tolerance policy regarding phones with flat batteries charging the customer the full fare for the journey, which has not helped overcome customers reluctance to use them.



## 7.5 Issues for consideration

### 7.5.1 Dependencies

The main dependencies in moving from a card centric system to an account based one are:

- The requirement for good near real time communications with all transport units (buses, coaches and train), to minimise risk of payment default;
- The need for good inspection and enforcement;
- Acceptance by operators of a primarily post-paid environment, which can be mitigated by adopting daily or weekly settlement;
- The provision of good preparatory and ongoing marketing to the public.

### 7.5.2 Risks

Given that we are suggesting a major change to the operating environment, location of data, access tokens and passenger experience, there will clearly be many risks associated with unforeseen problems resulting in delays or added costs. These will be inherently non-technical, for example:

- Not all operators wish to participate in multi-operator capping or are slow to adopt it;
- Current suppliers do not all co-operate in making the changes, either by not sharing, or making interfacing unduly expensive;
- Operators cannot agree on business rules;
- Operator's existing contractual commitments preclude them joining the scheme;
- The ABT scheme supplier experiences delays in delivering an acceptable solution.

With good project management most of these are thought to be readily manageable. However, some risks are more likely to remain of concern:

- First ride loss: in a post-paid environment, even with near real time communications, it is not possible to verify the passenger as having means and funds to pay their fare when they start a trip or alight at the end of their journey. Hence there is a risk of loss until the payment for the fare is validated and paid. In the case of use of a cEMV card the risk may be mitigated by the acceptance of risk by the card account owner. In the case of a transport token, the risk will be mitigated by the speed with which usage data is forwarded to the back office, the fare for the journey leg calculated, and the token hot listed;
- National decisions by Government or large transport operators such as Stagecoach, GoVia and Abellio, could frustrate Cambridgeshire's plans. It will be important to include them all in discussions about the plans and get their assurance that they will do nothing to hinder the planned activity;
- ENCTS currently requires a card centric ITSO environment and until that changes, Cambridgeshire cannot drop support for it. This might result in significantly added cost in supporting multiple systems in the longer term.

## 8. Delivery plan

This section sets out the steps the GCP would need to take to put in place a scheme based on the recommended approach, multi-token Account Based Ticketing (ABT) enabling use of cEMV bank cards, ITSO smart and mobile phones as tokens.

### 8.1 Proposed Deliverables

The recommendations made in this report (section 7) result in the proposed deliverables and timescale which we believe to be realistic.

Current Situation: cEMV Model 1 (bank cards) cash replacement, ITSO smart and mobile phone ticketing on Stagecoach bus and rail services. ENCTS passes are accepted on bus.

Deliverable #1 March 2021: cEMV Model 1 cash replacement on all Greater Cambridge bus services.

Deliverable #2 February 2022: Multi-token ABT on all Greater Cambridge bus services.

Deliverable #3 June 2022: Multi-token ABT extended to Greater Cambridge rail services.

### 8.2 Project Roadmap

This may be expressed graphically showing the intermediate steps in the programme.

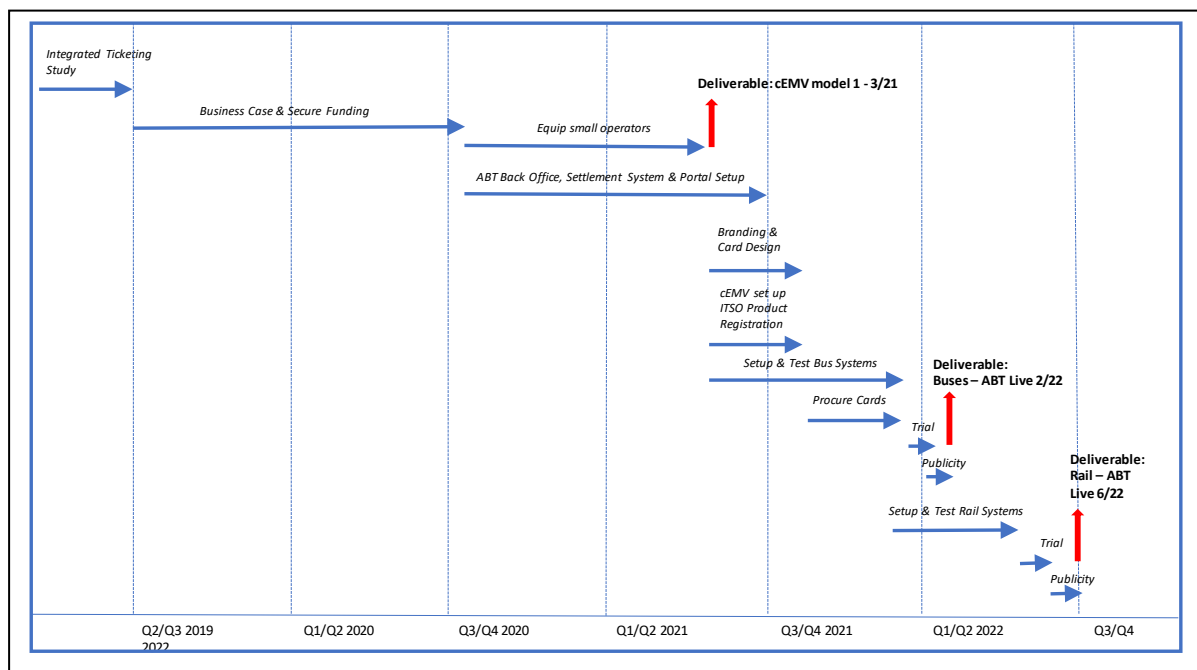


Figure 14 – Project Roadmap and Deliverables

A project management plan will structure the project activities required to support the implementation and delivery steps. The order of the following activities is not meant to imply their specific time sequence with respect to one another.

#### **8.2.1 Business case and Securing Funding**

Objective: Secure project funding.

Tasks: Prepare a business case; identify funding sources; and apply for funding.

Estimated completion: August 2020.

Capital Indicative ROM Cost: £188,000

Operational Indicative ROM Cost: Nil.

#### **8.2.2 Account Based Ticketing (ABT) Back Office System**

Objective: Procure a functioning back office system, including the a settlement system, customer facing internet portal and setting up cEMV communications with the various Payment Service Providers.

Tasks: Specify requirements; conduct a procurement exercise selecting a supplier; oversee implementation, configuration and commissioning; and conduct testing.

Estimated Completion: June 2021.

Capital Indicative ROM Cost: £500,000

- Assuming an off the shelf system, this covers the set-up cost, first year licence and technical support for procurement and implementation.

Operational Indicative ROM Cost: £200,000 PA.

#### **8.2.3 Operator Agreements**

Operators as a subset of stakeholders must show agreement via buy in which should be received early and made part of the business case. Once the supply contracts are let and a final design specification produced, a stakeholder confirmatory review is essential before starting the build.

Objective: Secure participation agreements with relevant transport operators

Tasks: Negotiate and sign off agreements.

Estimated Completion: June 2021.

Capital Indicative ROM Cost: Nil (it is assumed that this work will be undertaken by internal staff).

Operational Indicative ROM Cost: Nil.

#### **8.2.4 Branding and Marketing**

Marketing must be started as soon as the project starts and continued all the way through the project as users must be kept informed of what, why and the benefit to them. Branding and smartcard, app and web page design can sometimes take many months

Objective: Finalise branding and an artwork for smart cards; and promote the scheme.

Tasks: Develop branding guidelines; design publicity material; design an artwork for smartcards; and marketing activities.

Estimated Completion:

- Branding: April 2021;
- Marketing: As required.

Capital Indicative ROM Cost: £60,000.

Operational Indicative ROM Cost: Nil.

#### 8.2.5 Bus – Enabling tasks

Objective: Enable use of ITSO smartcards, cEMV cards and mobile phone apps (using cEMV) as tokens on bus, covering services provided by Stagecoach, Whippet and the Greater Cambridge small operators.

Tasks:

- Configure Stagecoach and Whippet ETMs;
- Upgrade the small bus operators with suitable ETMS and configure these; and
- Testing.

Estimated Completion: October 2021.

Capital Indicative ROM Cost: £330,000.

Operational Indicative ROM Cost: 35,000 PA (covering the small operators only, assuming that Stagecoach and Whippet will fund their own ongoing costs).

#### 8.2.6 Smartcard Manufacture

Objective: Procure ITSO smartcards for trials and full launch.

Tasks: Procure a supplier; inspect & test sample cards (made to the scheme specification); procure cards for the trial and launch.

Estimated Completion: As required to support trials and launches.

Capital Indicative ROM Cost: £104,000.

Operational Indicative ROM Cost £21,000 PA.

#### 8.2.7 Bus System Trial

Objective: A short trial to prove that the system functions correctly in the live environment, testing all functions, performance, operator and user acceptability. A key part of this trial will be ensuring that journey start and end points are correctly identified, and that the correct fares are charged.

Tasks: Set up and run the trial, monitor outcomes.

Estimated Completion: November 2021

Capital Indicative ROM Cost: Nil.

Operational Indicative ROM Cost: Nil.

### 8.2.8 Bus System Launch Publicity and Launch (part of marketing)

Objective: Publicise and launch the system

Tasks: Arrange publicity and a launch event.

Estimated Completion: February 2022.

Capital Indicative ROM Cost: Covered under Branding above.

Operational Indicative ROM Cost: Covered under Branding above.

### 8.2.9 Rail Enabling Tasks

Objective: Enable rail gates and validators support for the system.

Tasks:

- Upgrade as necessary and configure rail gates and validators for cEMV model 2 and use of ITSO cards as a token;
- Testing.

Estimated Completion: April 2022.

Capital Indicative ROM Cost: £100,000.

Operational Indicative ROM Cost: Nil (Assuming that the rail operators will fund their ongoing costs).

### 8.2.10 Rail System Trial

Objective: A short trial to prove that the system functions correctly in the live environment, testing all functions, performance, operator and user acceptability. A key part of this trial will be ensuring that journey start and end points are correctly identified, and that the correct fares are charged.

Tasks: Set up and run the trial, monitor outcomes.

Estimated Completion: May 2022.

Capital Indicative ROM Cost: Nil.

Operational Indicative ROM Cost: Nil.

#### 8.2.11 Rail System Launch Publicity and Launch

Objective: Publicise and launch the system

Tasks: Arrange publicity and a launch event.

Estimated Completion: June 2022.

Capital Indicative ROM Cost: Covered under Branding above.

Operational Indicative ROM Cost: Covered under Branding above.

#### 8.2.12 Miscellaneous Support

Objective: Procure project management, technical, assurance, gateway and testing support.

Tasks: Provision of support as required.

Estimated Completion: June 2022.

Capital Indicative ROM Cost: £181,000.

Operational Indicative ROM Cost: Nil.

## 9. Appendix 1 – List of interviewees

Interviewee	Position	Organisation
Charlie Hamilton	MD	Whippet
Chris Jefferies	Account Manager	ACT
Daniel Clarke	Smart Cambridge Program Manager	The Greater Cambridge Partnership
Jan Anderson	Account Manager	Rambus
Kamelia Lazarova	Smart Ticketing Scheme Manager	Abellio Greater Anglia
Lucy Whitehead	Group Innovation Lead	Stagecoach
Malcolm Cotter	Head of Retail Systems	Abellio Greater Anglia
Nigel Cullum	Business Development Manager	ITSO Ltd
Sherisse Shelton-Smith <sup>49</sup>		GTR Thameslink Great Northern

Table 23 – List of interviewees

## 10. Appendix 2 – Reference Documents

Document	Originator	Date
Integrated Ticketing Feasibility Study	ARUP	20 <sup>th</sup> April 2017

Table 24 – Reference Documents

## 11. Appendix 3 – Glossary of Abbreviations

Abbreviation	Term
ABT	Account Based Ticketing
AFC	Automatic Fare Collection
AGA	Abellio Greater Anglia
AMS	Asset Management System (a HOPS module)
App	Mobile phone application
BLE	Bluetooth Low Energy
BiBo	Be in – Be out (ticketing technique)
CA	Combined Authority
CAM	Cambridge Autonomous Metro
cEMV	Contactless EMV (Bank) card
CMS	Card/Customer Management System
DfT	Department for Transport
ENCTS	English National Concession English National Concessionary Travel Scheme
ETM	Electronic Ticket Machine
GTR	Govia Thameslink Railway

<sup>49</sup> By email only

HOPS	Host Operator Processor System (the ITSO specified back office)
ID	IDentity
IPE	ITSO Product Entity (encoded within cards)
ISAM	ITSO Security Access Module
ISMS	ITSO Security Management System
ITSO	The membership organisation maintaining and promoting the ITSO specifications, and providing the security and certification structure. <a href="http://www.itso.org.uk">www.itso.org.uk</a>
LEP	Local Enterprise Partnership
MaaS	Mobility as a Service
NFC	Near Field Communications
OAG	Operations Advisory Group (an ITSO group)
PAYG	Pay as you Go ticketing service
POST	Point Of Sale Terminal (e.g. an ETM)
RDG	Rail Development Group
RfID	Radio frequency Identification
ROM	Rough Order of Magnitude
RSP	Rail Settlement Plan
TCA	Travel Card Authority
TfL	Transport for London
TiTo	Touch in – Touch out (ticketing technique)
TOC	Train Operating Company

*Table 25 – Glossary of Abbreviations*

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